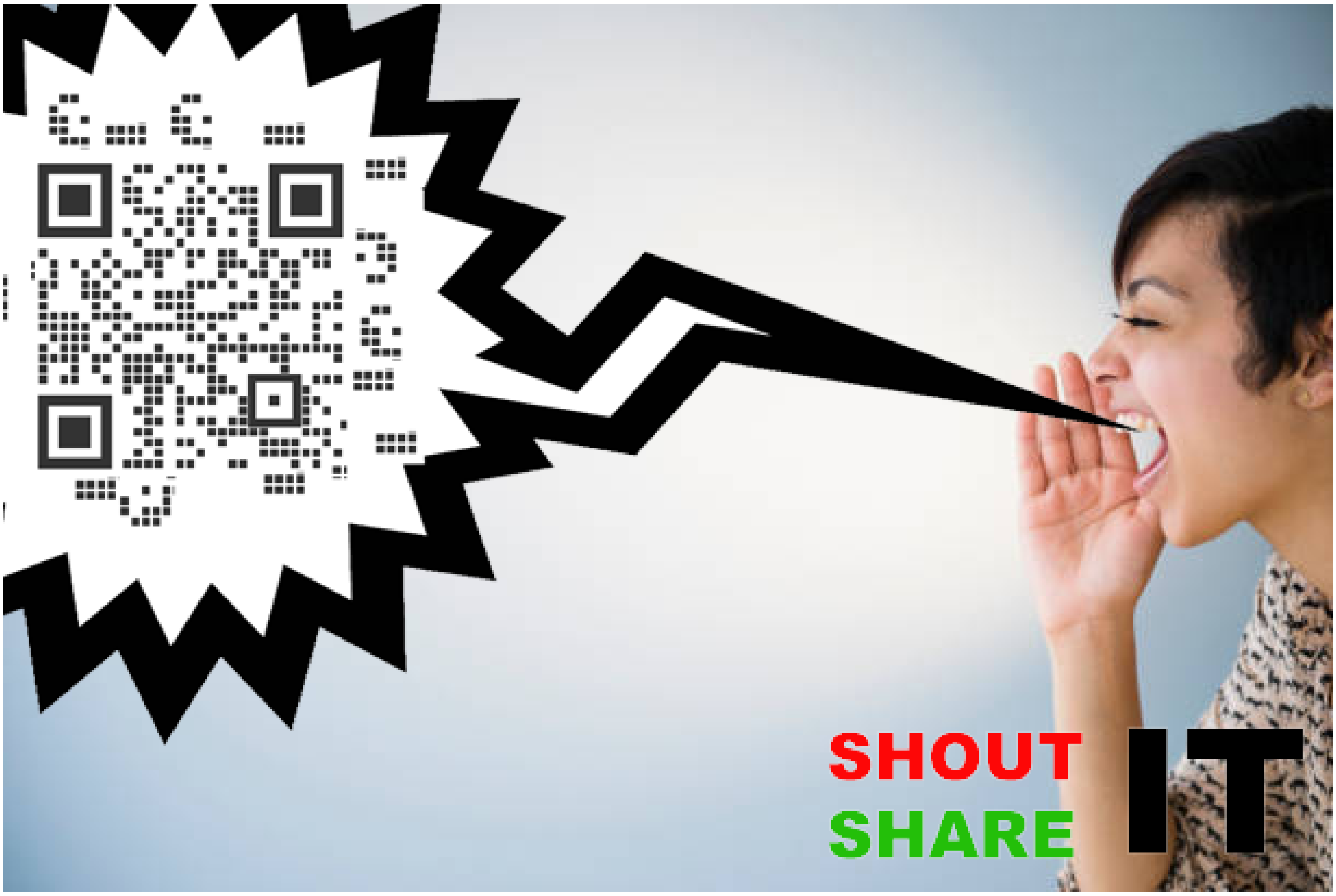

SHOUT
SHARE
IT

HARVARD UNIVERSITY.

LIBRARY

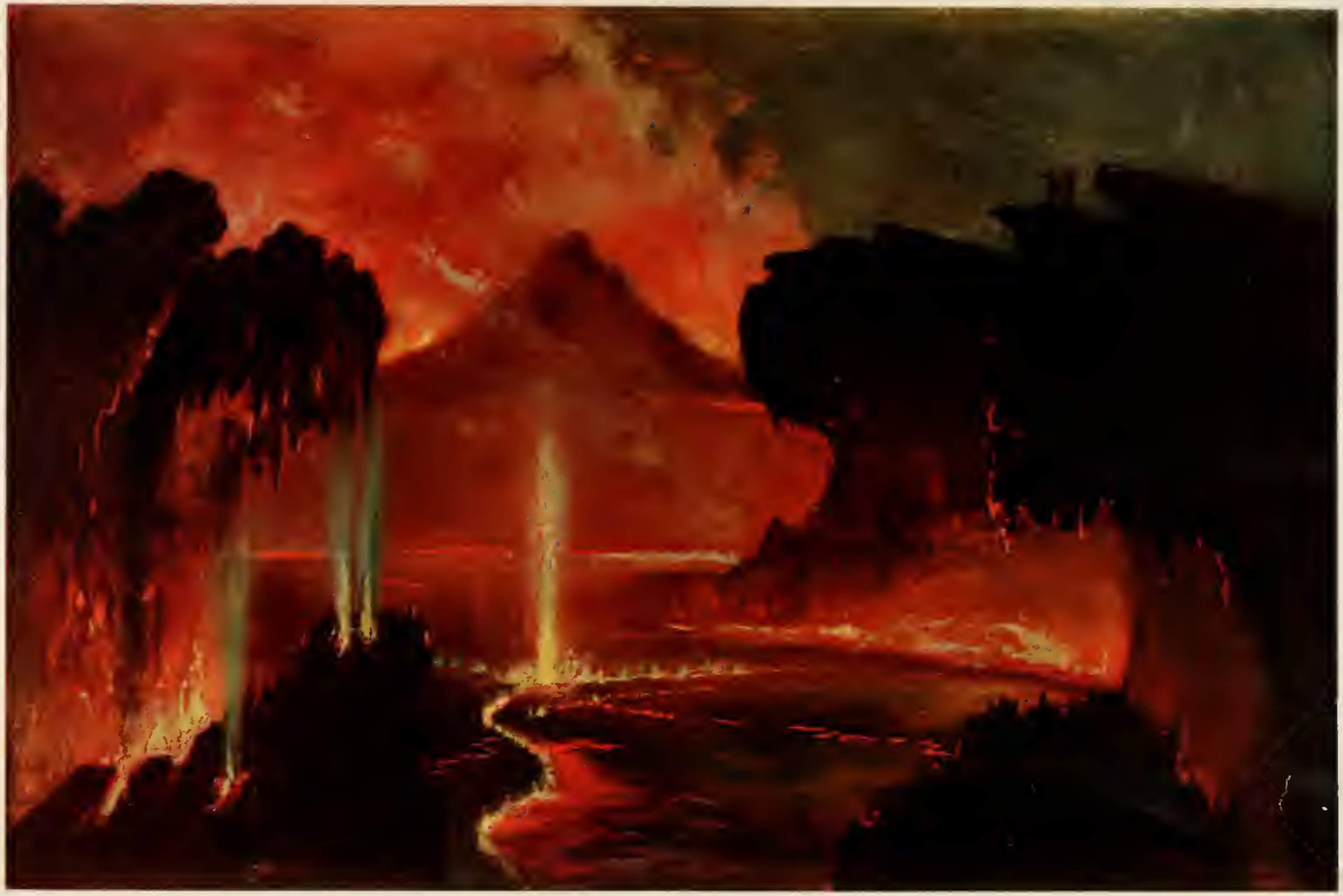
OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY.

14,372

Exchange.

March 6, 1906 - January 3, 1909



HALEMAUMAU 1880 C. FURNEAUX

Memoirs Bernice Pauahi Bishop Museum II.

MEMOIRS

OF THE

BERNICE PAUAHI BISHOP MUSEUM

OF

POLYNESIAN ETHNOLOGY AND NATURAL HISTORY

VOLUME II.

HONOLULU, H. I.
Bishop Museum Press
1906–1909

TABLE OF CONTENTS

I. Hawaiian Mat and Basket Weaving: By William T. Brigham.
Hawaiian Nets and Netting: By John F. G. Stokes.
Issued February, 1906.

II. Old Hawaiian Carvings: By William T. Brigham.
Issued May, 1906.

III. The Ancient Hawaiian House: By William T. Brigham.
Issued June, 1908.

IV. Kilauea and Mauna Loa, Volcanoes on the Island of Hawaii: By William T. Brigham.
Issued December, 1909.

LIST OF PLATES

1. Hawaiian Mat and Basket Weaving.—Hawaiian Nets and Netting.

I. Micronesian Baskets.
II. Micronesian Baskets.
III. Hawaiian Sandals.
IV. Hawaiian Fish-baskets or Traps.
V. Corner of Pandanus Leaf Mat.
VI. Plait in Hinai poepoe.
VII. Cover of Ieie Basket.
VIII. Basket Covering of a gourd.
IX. Hinai poepoe.
X. Beginning of a Makaloa Mat.
XI. Portion of Makaloa Mat.
XII. Portion of Makaloa Mat.
XIII. Portion of Makaloa Mat.
XIV. Group of Modern Hawaiian Fans.
XV. Native Scraping Oloná.
XVI. Makaloa Mat in Color. *Frontispiece.*

2. Old Hawaiian Carvings.

XVII. Aumakua found in Cave.

3. The Ancient Hawaiian House.

XVIII. Pago Pago Harbor. J. Martin.
XIX. King's House, Mbau. Waitovu, Fiji. Lindt.
XX. Na Kali; Fijian House. Lindt.
XXI. Maori Carved House.
XXII. Maori Carvings.
XXIII. New Hebridean Huts.
XXIV. Communal House, New Guinea.
XXV. High House, New Guinea.
XXVI. Hawaiian House Framing.
XXVII. Hawaiian House Thatching.
XXVIII. Hawaiian House Completed.
XXIX. Hawaiian Cords.
XXX. Ipu holoi lima.
XXXI. Ipu aina with Inserted Teeth.
XXXII. Ipu kuha or Spittoons.
XXXIII. Gourd Bottles for Fishing Lines.
XXXIV. Hawaiian Stirrers and Knives.
XXXV. Hawaiian Carvings in British Museum.
XXXVI. Decorated Gourd Vessels.
XXXVII. Carved Coconuts.
XXXVIII. Hawaiian Umeke.
XXXIX. Hawaiian Umeke.
XL. Hawaiian Umeke.

4. Kilauea and Mauna Loa: Volcanoes on the Island of Hawaii.

XLI. Lava Fall, near Hilo.
XLII. Descent into Halemaumau.
XLIII. Sentinels and Overflow in Kilauea.
XLIV. Pools in Halemaumau.
XLV. Cone and Pool, Halemaumau.
XLVI. Drawn Lava from Fall.
XLVII. Aa, Natural Size.
XLVIII. Cave Stalagmite, Slender.
XLIX. Cave Stalagmite, Stout.
L. Pool in Halemaumau.
LI. Pool in Halemaumau from below.
LII. Pool in Halemaumau, from above.
LIII. South Lake and Island.
LIV. Cone in Halemaumau.
LV. Double Cone in Halemaumau.
LVI. Cone in Halemaumau.
LVII. The Empty Pit.
LVIII. On the Brink of the Pit.
LIX. Cracked Banks of Lava Pool.
LX. Dana Lake.
LXI. South Lake.
LXII. Floating Islands.
LXIII. Flow of Aa.
LXIV. Source of Flow 1880-81.
LXV. Crack in Floor of Kilauea.
LXVI. Kilauea in 1896. D. Howard Hitchcock.
LXVII. Mokuaweoweo in 1896. D. H. Hitchcock.
LXVIII. Halemaumau, 1880. Furneaux. *Frontispiece.*

ILLUSTRATIONS IN THE TEXT

While each Memoir is paged independently, the pagination of the volume will be found at the bottom of the page.

MEMOIR I.

		PAGE
1.	Coconut Leaf Basket	3
2.	Hawaiian Ki Leaf Basket	4
3.	Coconut Leaf Baskets from Tutuila	5
4.	Coconut Leaf Basket. Shortland I.	6
5.	Palm Basket. Ponape	7
6.	Coco Leaf Basket. Caroline Islands	7
7.	Closure of Basket Bottom	7
8.	Fans from Solomon Islands	8
9.	Hawaiian Coco Leaf Fans	9
10.	Hawaiians Fans, British Museum	10
11.	Ancient Hawaiian Fan, Bishop Museum	11
12.	Various Fans	12
13.	Samoan Fans	12
14.	Structure of Fans	13
15.	Fijian Palm Leaf Fans	14
16.	Marshall Islands Fans	15
19.	Caroline Islands Basket	16
20.	Course of Strips	16
21.	Solomon Islands Shield	17
22.	Solomon Islands Rattan Shields	18
23.	Gilbert Islands Coco Fibre Armor	19
24.	Ponape Sennit Basket	20
25.	Rolls of Sennit	21
26.	Tongan Basket, British Museum	22
27.	Tongan Open-work Mats	22
28.	Coco Cords from Micronesia	22
29.	Palm Leaf Hats. Guam	23
30.	Palm Leaf Basket. Solomon Islands	24
31.	Bottom of Basket. Solomon Islands	24
32.	Inside of Basket. Solomon Islands	25
33.	Basket from New Hebrides	25
34.	Basket from Florida, S. I.	26
35.	Basket from Santa Cruz	27
36.	Baskets from Pelew Islands	27
37.	Pandanus Grove, Puna, Hawaii	28
38.	Rolls of Pandanus Leaves	29
39.	Pandanus Hats, Caroline Islands	30
40.	Pandanus Mat from Ebon	31
41.	Large Ebon Mat	32
42.	Caroline Islands Mat Bed	33
43.	Structure of Caroline Mat Bed	33
44.	Hawaiian Pillows	34
45.	Hawaiian Pandanus Baskets	35
46.	Hawaiian Covered Pandanus Baskets	36
47.	Samoan Round Baskets	37
48.	Samoan Square Baskets	38
49.	Marshall Islands Mat, Folded	43
50.	Lap Board and Strip of Mat Sail	46
51.	Pandanus Satchel. Fiji	48
52.	Marshall Islands Mat	49
53.	Mats. Marshall Islands	50
54.	Mallets for Beating Pandanus Leaves	51
55.	The Beginning of a Pandanus Mat	54
56.	Women's Dress from Malekula	56
57.	Fijian Coffin-shaped Basket	57
58.	Freycinetia Leaves	60
59.	Freycinetia Rootlets	60
60.	Basket of Ieie	61
61.	Edge of Basket	63
62.	Hinai poepoe	64
63.	Mouth of Hinai poepoe	65
64.	Bottom of Basket	66
65.	Hinai poepoe	67
66.	Hawaiian Flat-topped Baskets	68
67.	Rim of Basket	68
68.	Hawaiian Fish Basket	69
69.	Enlarged Portion of Fish Basket	70
70.	Wicker Work Helmet	71
71.	Helmet of Ieie	71
72.	Hawaiian Fern Stem Hat	72
73.	Japanese Fern Stem Basket	73
74.	New Zealand Fish Baskets	74
75.	Hawaiian Fern Stem Fish Traps	75
76.	Plan of Sandal	76
77.	Niihau Makaloa Mat	78
78.	Keekee Pattern	79
79.	Olowahia and Kahanu Patterns	80
80.	Puakala, Papaula, Humuniki Patterns	81
81.	Mat Patterns	82
82.	Mat Belonging to Kamehameha I	83
83.	Mat Designs	83
84.	Grass Mat	84
85.	Solomon Islands Comb	85
86.	Baskets from Northern Australia	86
87.	Coiled Basket, Australian Museum	87
88.	Coiled Basket from Gippsland	88
89.	Australian Baskets	89
90.	Decorated Dilly Basket	90
91.	Plain Dilly Basket	90
92.	Keke of Harakake Fibre	91
93.	Maori Satchels	92
94.	Maori Basket Satchel	93
95.	Ie Sina, Samoa	94
96.	Loom from Caroline Islands	96
97.	Mats of Banana Fibre. Caroline Islands	99
98.	Frame for Tol Weaving	100

PAGE
99. Tol of Complicated Pattern 101
100. Aprons and Tols 103
101. Mesh Gauges 106
102. Shuttles 107
103. Net Menders 108
104. Koko with Umeke 113
105. Koko with Umeke 113
106. Huewai 114
107. Olowai 114
108. Koko Puupuu 115
109. Native with Auamo 116
110. Piko A, Hanai C 117
111. Piko A, Hanai C 117
112. Piko B, Hanai B 118
113. Hanai D 119
114. Piko C, Hanai A 119
115. Hanai F 119
116. Piko D 120
117. Piko E 120
118. Piko E, Hanai A 120
119. Piko F 121
120. Piko F, Obverse 122
121. Piko F, Reverse 123
122. Piko F 124
123. Piko G 125
124. Piko H 126
125. Piko J 126
126. Piko J 127
127. Piko K 128
128. Piko L 128
129. Piko M 129
130. Piko N 129
131. Piko N, Hanai G 130
132. Piko O 131
133. Piko O, Hanai D 131
134. Hanai A+B 132
135. Hanai B 132
136. Hanai C, Piko D 133
137. Hanai D 133
138. Hanai E 134
139. Hanai F 135
140. Hanai G 135
141. Hanai G 135
142. Hanai H 136
143. Hanai H 136
144. Hanai H+J 136
145. Hanai J 137
146. Hanai K 137
147. Hanai L 138
148. Hanai M 140
149. Foreign Bag 141
150. Technique of Foreign Knot 142
151. Hanai of Plain Knitting 142
152. Samples of Koko 143
153. End of Auamo, Showing Pu uo 144
154. Detail of Aha hawele 147
155. Huewai pueo with Aha hawele 148
156. Huewai with Aha hawele 149
157. Huewai with Aha hawele 149
158. Ipu lei 150
159. Ipu lei 150
160. Poho aho with Cords 151
161. Huewai with Cord Handles 151
162. Gourd Umeke with Cords 151
163. Commencement of a Net 153
164. Samples of .4 inch Mesh 159
165. Diagram of Upena nae kuku 161
166. Hano ohua 162

Memoir 2.

PAGE
Aumakua Guardians of Cave Title Page
1. Plan and Section of Cave 166
2. Female Portrait Statuette 167
3. Portrait Statuette of Girl 168
4. Statuettes in Profile 169
5. Side View of Aumakua 170
6. Back View of Aumakua 171
7 Carved Bowl 172
8. Interior of Carved Bowl 173
9. Carved bowl End View 173
10. Carved Bowl, other End View 173
11. Inlaid Ipu aina 174
12. Ipu aina in Bishop Museum 175
13. Papamu or Konane Board 176
14. Bowl with Carved Supports 176
15. Carver with Human Bone Handle 177
16. Carver in British Museum 177
17. Compressed Gourd Bottle 179
18. Net of Feather Cape 180
19. Wooden Funnel 181
20. Foreign Fan 181
21. Fragment of Chinese Procelain 182

Memoir 3.

PAGE
1. Honolulu in 1837 187
2. Marquesan Village 189
3. Tahitian Queen's House 190
4. Tahitian Village 191
5. Tahitian Chief's House 192
6. Tongan Interior 193
7. Tongan Pillow 195
8. Wooden Stools 195
9. Kapa Drinking in Tonga 196
10. Samoan House 198
11. Samoan Interior 199
12. Samoan Palace 200

PAGE
13. Samoan Bambu Pillows 201
14. Samoan House 202
15. Samoan Temples (Stair) 203
16. Fijian Interior of Rewa 204
17. Modern Fijian House 205
18. Fijian Pillows in Bishop Museum 206
19. Sections of Fijian Houses 207
20. Fijian Sennit Work on Walls 208
21. Door of Fijian House 209
22. A Mbure in Mbau. Fiji 211
23. Maori House or Hut 215
24. Poupou and Tukutuku. Ohinemutu 216
25. Maori Carved House 217
26. Entrance to a Maori House 218
27. Tekoteko from Maori Gable 219
28. Group of Gable Images 220
29. Pataka in Auckland Museum 221
30. Poupou from Maketu 222
31. Maori Mythical Carving 222
32. Interior of Maori House. Rotorua 223
33. Doorway of Pataka 224
34. Central Slab of Pataka 224
35. Maori Carving a Poupou 225
36. Scene on Atafu. Agate 226
37. Coconut Grove and House. Fakaafo 227
38. Mariapu at Uteroa 228
39. Interior of Mariapu 229
40. Model of a Maiana House 230
41. Model of a Kusaian House 231
42. Gable End of a Kusaian House 232
43. Woven Walls of Niue House 234
44. New Guinea Village 235
45. Village Street in New Guinea 236
46. Sacred House at Dorei 237
47. Village on Duau 238
48. House in Milne Bay 239
49. New Guinea Pillows 240
50. Long House in New Guinea 241
51. A Tree House in New Guinea 242
52. Tree Houses in New Guinea 243
53. Club House for Young Men 244
54. House Front in Kiriwina 245
55. A Kiriwina Village 246
56. Aneiteum Hut, Original Type 247
57. Aneiteum Hut with Red Front 247
58. Village in Malekula 248
59. House Thatching in New Hebrides 249
60. New Caledonian House 250
61. Solomon Islands House 251
62. Pile Dwellings on Fauro 252
63. Australian Hut 255
64. View on Kauai by Weber 257
65. Houses of Kalaimoku in Honolulu 258
66. House at Kailua, Hawaii 264
67. Hakakau for Calabashes 265
68. Hawaiian Pump-drill 269
69. Ball of Braided Grass 270
70. Sennit in Native Rolls 271

PAGE
71. Diagrams of Houses Forms 272
72. Hale Kamani at Lahaina 273
73. The Pou of a House 274
74. Pou from Waialua 275
75. Pou from Waialua 275
76. Diagram of a House Plan 276
77-80. House Timbers 277
81. Junction of Rafters 278
82. Junction of Rafter and Post 278
83. House near Hilo out of Repair 279
84. House near Puna with Lanai 280
85. Grass House with Net over it 282
86. Sacred House with Kapu Sign 284
87. Grass House of the Poorer Sort 285
88. Village on Niihau. Ellis 289
89. House at Kealakeakua 290
90. Ellis' View of Houses at Kealakeakua 290
91. Village on Hawaii. Ellis 291
92. Hale kauila in Honolulu 292
93. Street View in Honolulu with Kinau 293
94. Hale lama at Waikiki 294
95. King's House at Kaunakakai 295
96. House at Kaimu, Hawaii in 1888 296
97. Old Volcano House. Hitchcock 297
98. Maori Fire-making 299
99. Hawaiian Fire-making Tools 300
100. Poi Making at Halawa, Molokai 308
101. Hawaiian Uluna or Pillows 309
102. Stone Pillow from Kauai 310
103. Kapa Beaters or Ie kuku 311
104. Kapa Making Outfit 312
105. Laau lomilomi and Bath Rubbers 313
106. Kukui Nut Candles 315
107. Stone Lamps 316
108. Stone Mortar 317
109. Poi Board and Pounders 318
110. Poi Boards of Ancient Make 318
111. Bearing the Poi of an Alii 319
112. Hawaiian Hay Dealer in 1864 320
113. Ends of Hawaiian Auamo 321
114. Gourd Containers 322
115. Bottle Gourd or Huewai 322
116. Mended Ipu 323
117. Gourd Box 324
118. Long Gourd Boxes 324
119. Gourd Hula Drums 325
120. Gourd Bottles for Canoes 326
121. Compressed Gourd Bottle 327
122. Gourd Funnels 328
123. Gourd Awa Strainer 329
124. Huewai Pawehe 330
125. Various Gourd Implements 331
126. Coconut Cups 332
127. Coconut Spoons and Ladles 332
128. Marquesan Carved Coconut Cup 333
129. Modern Hawaiian Coconut Cups 334
130. Solomon Islands Coconut Cup 335
131. Fijian Cup and Wiper 336

PAGE
132. Micronesian Water Bottles 337
133. Coconut Bottles. Solomon Islands 338
134. Coconut Tobacco Boxes 338
135. Coconut Cups of High Chiefs 338
136. Umeke 416: Very Old 339
137. Umeke 417: Very Old 340
138. Umeke 410; Very Old 341
139. Umeke opaka of Kou Wood 342
140. Blocks Partly Shaped Long ago 343
141. Polyhedral Umeke 344
142. Deep Umeke 345
143-145. Umeke 346
146. Umeke 347
147. Modern Turned Umeke 347
148. Comparative Size and Shape of Umeke 347
149. Umeke 348
150. Umeke of Unusual Form 349
151-152. Umeke 350
153. Umeke with Lugs for Suspension 351
154. Umeke with Cover 352
155. Hawaiian Pa or Dishes 353
156. Lute-shaped Bowls 354

PAGE
157. Large Hawaiian Dishes with Legs 355
158. Kanoa awa: Awa Bowls 355
159. Umeke of Kamehameha I 356
160. Dishes with Compartments 357
161. Banded Umeke 357
162. Hawaiian Carved Dishes 358
163. Maori Carved Dish 358
164. Carved Dish in Leiden Museum 359
165. Long Platters. Deverill Coll 360
166. Long Platters 361
167. Broad Platters 361
168. Outlines of Typical Umeke 362
169. Odd Shaped Finger Bowl 366
170. Ipu holoi lima or Finger Bowls 367
171. Finger Bowl with Grit Holder 367
172. Ipu aina or Slop Bowls 368
173. Hawaiian Mirrors, Foreign Glass 372
174. Hawaiian Mirror in British Museum 372
175. Uhi kahi olona; Scrapers 374
176. Ipu le'i for Fish Hooks and Lines 375
177. Bow, Arrow and Broom 376
178. Polynesian Stools 377

MEMOIR 4.

PAGE
Map of Hawaii Showing Lava Flows 381
1. Old Flow West of Kilauea 382
2. Limu from Kilauea, 1789 383
3. Pots on Wailuku near Hilo 384
4. Mauna Kea from Waiakea, Hilo. Perkins 384
5. Cinder Cones on Mauna Kea 385
6. Pool on Mauna Kea, August, 1889 385
7. Summit of Hualalai from East 386
8. Pit Crater on Hualalai, 1889 387
9. Blow-hole on Hualalai, 1889 389
10. Hualalai from Mauna Loa (9000 ft.) 390
11. Mauna Loa from Top of Hualalai 391
12. Breaking Camp, Hualalai, 1889 393
13. Mauna Loa from Kilauea, 7 A.M 396
14. Halemaumau in 1888. Furneaux 398
15. Pele's Hair from Kilauea 399
16. Form of Less Fusible Lava 399
17. Rope Lava 400
18. Driblet under Lava Fall 400
19. Sectional Impression of Rope Lava 402
20. Palagonite from Diamond Head 403
21. Stony Cellular Lava 403
22. Lava with Cylindrical Cells 403
23. Vase Made from Molten Lava 404
24. Black Volcanic Sand 404
25. Basaltic Prisms in Wailuku Gorge 405
26. Halemaumau Smoking 406
27. Stalactites from Cave near Hilo 408
28. Stalagmites from a Cave in Kilauea 409
29. Blow-hole Specimen 410
30. Fragmentary Lava 412
31. On the Old Trail to Kilauea 413

PAGE
32. Section on Road North of Kilauea 415
33. Uwekahuna from Volcano House 416
34. Cracks at Ponahohoa. Ellis 417
35. Kilauea as Seen by Ellis 418
36. Ellis' View of Kilauea. Polyn. Researches 419
37. Dampier's Kilauea in 1825 422
38. Malden's Plan of Kilauea in 1825 423
39. Kilauea iki, Showing Lava Streams 425
40. Kilauea, by Parker & Chase. Dana 426
41. Wall on North of Kilauea 427
42. Map of Source of 1840 Eruption 429
43. Lava Around Trees in Puna. Henshaw 431
44. Kilauea in 1841. Wilkes 433
45. Kilauea in 1841. Drayton 434
46. Diagram in the Coan Letter 436
47. Lyman's Plan of Kilauea in 1846 437
48. Lyman's Revised Plan 438
49. Survey of Mokuaweoweo, 1841. Wilkes 442
50. The Cathedral from West and Northwest 453
51. Fountain, Feb. 6 and 7, 1859 454
52. Fountains Feb. 10, 1859 455
53. North End of Kilauea 458
54. Northern Sulphur Bank in 1889 459
55. Fumarole with Sulphur Crystals 460
56. Kilauea in 1864. Perry 461
57. Floor with Spatters 462
58. Bottom of Previous Fragment 463
59. Survey of Kilauea, 1865. Brigham 465
60. Kilauea iki 467
61. Fragment of Flow of 1862 468
62. Keanakakoi in 1889 469
63. Craters at Kapoho, Puna 473

PAGE
64. Crater Makaopuhi in Puna 474
65. Kapoho Craters 476
66. Green Pool, Puna 477
67. Warm Spring, Puna 478
68. Earthquake Ruins, 1868 481
69. Kilauea After Eruption, 1868 485
70. Lydgate's Survey of Kilauea, 1874 498
71. Crater of Kilauea 499
72. Mokuaweoweo. W. W. Hall 500
73. Lydgate's Mokuaweoweo 501
74. Kilauea in December, 1874 502
75. Kilauea in February, 1875 507
76. Crack in Floor of Kilauea, 1877 509
77. Sketch of Halemaumau, Jan. 1880 511
78. An Improved Volcano House. Williams 512
79. Kilauea in 1880. Furneaux 513
80. Northward from Southeast Lake 515
81. Diagram of Elevation 516
82. Halemaumau from Kau Bank, 1880 518
83. Lava Spring 519
84. Bath on Sulphur Bank, 1880. Silva 520
85. Mokuaweoweo Plan 522
86. Halemaumau in 1880. Furneaux 525
87. Diagram, Source of Flow, 1880 526
88. View of the Source. Furneaux 527
89. Lava Stream in a forest. Furneaux 528
90. Waterspout on the flow of 1881. Furneaux 530
91. Flow of 1881 near Hilo. Furneaux 531
92. Eruption from Kawaihae Bay. Furneaux 533
93. Little Beggar in 1889 535
94. Government Survey of Mokuaweoweo 537
95. Halemaumau After Eruption of 1886 541
96. Source of Eruption of 1887. Furneaux 543
97. Course of Flow of 1887. Furneaux 544
98. End of Flow of 1887. Furneaux 544
99. Survey of Halemaumau, July, 1888 548
100. Spatter Cone in Kilauea, 1889 550
101. Lava Fall North of Halemaumau 550
102. Under East Wall of Kilauea 551
103. Pile of Crusts North of Halemaumau 551

PAGE
104. Crack in Bed or Kilauea 552
105. Floor of Kilauea, 1890 553
106. About Halemaumau, 1890 554
107. Halemaumau After the Downfall 555
108. Cracks on the Brink of the Pit 557
109. New Portion of Volcano House 558
110. Halemaumau in October, 1891 559
111. Dodge's Survey of Halemaumau, 1892 560
112. Dodge's Survey from V. H. Register 561
113. Section of Halemaumau, 1892 562
114. Bishop's Plan of the Lakes 563
115. Comparative Sections 564
116. Section of Halemaumau, July, 1894 565
117. Outline of Island in Lake 567
118. Dodge's Survey of Halemaumau, '94 568
119. Dodge's Survey: another copy 569
120. Friedländer's Mokuaweoweo in 1896 571
121. Friedländer's Mokuaweoweo by Night 572
122. Map of Mokuaweoweo, 1896 573
123. Map of Halemaumau 575
124. Hitchcock's View of Eruption 577
125. Eruption of Mokuaweoweo by Day 579
126. Eruption of Mokuaweoweo by Night 579
127. Map of Eruption 581
128. Camp on Mauna Loa, 1905. Pope 582
129. Halemaumau in December, 1906 583
130. Western Wall of Mokuaweoweo. Pope 584
131. Eastern Wall of Mokuaweoweo. Pope 585
132. Moving Mass of Aa in 1907. Perkins 586
133. Front of Aa Flow, 1907. Perkins 586
134. Thurston's Plan of Fire Pool 587
135. Biart's Plan of Fire Lake 587
136. Halemaumau, August, 1908. Perkins 588
137. Surface of Lava by Night. Perkins 589
138. Surface of Lava by Night. Perkins 589
139. Halemaumau from Northwest. Perkins 591
140. Halemaumau Before the Break. Thrum 592
141. Halemaumau, August, 1909. Reed 593
142. Section of Fire Pit. Baldwin 595
143. Lydgate's Survey of Halemaumau 597

14372

MEMOIRS

OF

THE BERNICE PAUAHI BISHOP MUSEUM

OF

POLYNESIAN ETHNOLOGY

AND

NATURAL HISTORY.

VOL. II. No. 1.

Hawaiian Mat and Basket Weaving, and Nets and Netting.

HONOLULU, H. I.:
BISHOP MUSEUM PRESS.
1906.

BOARD OF TRUSTEES.

Sanford B. Dole, LL.D.	President
William O. Smith	Vice-President
Alfred W. Carter	Secretary
Joseph O. Carter	Treasurer

Samuel M. Damon   Henry Holmes   E. Faxon Bishop

MUSEUM STAFF.

William T. Brigham, Sc.D. (Columbia)	Director
William H. Dall	Honorary Curator of Mollusca
William A. Bryan	Curator of Ornithology
John F. G. Stokes	Curator of Polynesian Ethnology
Leopold G. Blackman	Assistant, and Acting Librarian
C. Montague Cooke, Jr., Ph.D. (Yale)	Assistant
John J. Greene	Printer

MAT AND BASKET WEAVING
OF THE
ANCIENT HAWAIIANS

DESCRIBED AND COMPARED WITH THE BASKETRY OF THE OTHER PACIFIC ISLANDERS.

BY WILLIAM T. BRIGHAM, A.M., Sc.D. (Columbia).

WITH AN ACCOUNT OF HAWAIIAN NETS AND NETTINGS
BY JOHN F. G. STOKES
CURATOR OF POLYNESIAN ETHNOLOGY IN THE MUSEUM.

MEMOIRS OF THE BERNICE PAUAHI BISHOP MUSEUM

Volume II, Number 1

HONOLULU
Bishop Museum Press
1906

LIST OF PLATES.

I. Micronesian baskets.
II. Micronesian baskets.
III. Hawaiian sandals.
IV. Hawaiian fish baskets or traps.
V. Corner of Pandanus leaf mat.
VI. Illustrations of plait in hinai poepoe.
VII. Cover of ieie basket.
VIII. Basket covering of a gourd.
IX. Hinai poepoe.
X. Beginning of a makaloa mat.
XI. Portion of a Niihau or makaloa mat.
XII. Portion of a Niihau or makaloa mat.
XIII. Portion of a Niihau or makaloa mat.
XIV. Group of Hawaiian fans.
XV. Native scraping oloná. (Cast from life.)
XVI. Makaloa mat, in color. (Frontispiece.)

ILLUSTRATIONS.

MATS AND BASKETS.

PAGE
1. Coconut leaf basket 3
2. Hawaiian ki leaf basket 4
3. Coconut leaf baskets from Tutuila 5
4. Coconut basket from Shortland Island 6
5. Palm basket from Ponape 7
6. Coco leaf basket from the Carolines 7
7. Closure of basket bottom 7
8. Fans from the Solomon Islands 8
9. Hawaiian coco leaf fans 9
10. Hawaiian fans in the British Museum 10
11. Ancient Hawaiian fan, Bishop Museum 11
12. Various fans 12
13. Samoan fans 12
14. Enlarged fans to show structure 13
15. Fijian palm leaf fans 14
16. Marshall Islands fans 15
19. Caroline Islands basket 16
20. Course of strips 16
21. Solomon Islands shields 17
22. Rattan shields from the Solomon Islands 18
23. Coco fibre armor, Gilbert Islands 19
24. End of sennit basket from Ponape 20
25. Rolls of sennit 21
26. Tongan basket in British Museum 22
27. Open work mats from Tonga 22
28. Coco cords from Micronesia 22
29. Palm leaf hats from Guam, Marianas 23
30. Basket of palm leaf, Solomon Islands 24
31. Bottom of basket of palm leaf, Solomon Ids. 24
32. Inside of basket of palm leaf, Solomon Ids .. 25
33. Basket from New Hebrides 25
34. Baskets from Florida, Solomon Islands 26
35. Baskets from Santa Cruz 27

PAGE
36. Baskets from the Pelew Islands 27
37. Pandanus grove in Puna, Hawaii 28
38. Rolls of Pandanus leaves 29
39. Pandanus hats from the Carolines 30
40. Pandanus mat from Ebon 31
41. Large Ebon mat 32
42. Mat beds from Caroline Islands 33
43. Structure of Caroline mat 33
44. Hawaiian pillows 34
45. Hawaiian Pandanus baskets 35
46. Hawaiian covered Pandanus baskets 36
47. Samoan round baskets 37
48. Samoan square baskets 38
49. Marshall Islands mat, folded 43
50. Lap board and strips of mat sail 46
51. Pandanus satchel, Fiji 48
52. Marshall Islands mat 49
53. Group of Marshall Islands mats 50
54. Mallets for beating Pandanus leaves 51
55. The beginning of a Pandanus mat 54
56. Women's dresses from Malekula, N. Hebrides 56
57. Fijian coffin-shaped basket 57
58. Freycinetia leaves 60
59. Freycinetia rootlets 60
60. Basket of ieie 61
61. Edge of basket 63
62. Hinai poepoe 64
63. Mouth of hinai poepoe 65
64. Bottom of basket 66
65. Hinai poepoe 67
66. Group of flat-topped Hawaiian baskets 68
67. Rim of basket 68
68. Hawaiian fish basket 69

PAGE
69. Enlarged portion of fish basket 70
70. Wicker work helmet 71
71. Helmet of ieie 71
72. Hawaiian fern-stem hat 72
73. Modern Japanese fern-stem basket 73
74. New Zealand fish baskets 74
75. Hawaiian fern-stem fish traps 75
76. Plan of sandal 76
77. Niihau makaloa mat 78
78. Keekee pattern 79
79. Olowahia and kahanu patterns 80
80. Puakala, papaula and humuniki patterns 81
81. Mat patterns 82
82. Mat belonging to Kamehameha I 83
83. Mat designs 83
84. Grass mat 84

PAGE
85. Solomon Islands comb 85
86. Baskets from Northern Australia 86
87. Coiled baskets in the Australian Museum 87
88. Coiled baskets from Gippsland 88
89. Australian baskets 89
90. Decorated dilly basket 90
91. Plain dilly basket 90
92. Keke of harakake fibre 91
93. Maori satchels 92
94. Maori basket satchel 93
95. Ie sina, Samoa 94
96. Loom from Caroline Islands 96
97. Mats of banana fibre, Caroline Islands 99
98. Frame for tol weaving 100
99. Tol of complicated pattern 101
100. Aprons and tols 103

NETS AND NETTINGS.

PAGE
101. Mesh gauges 106
102. Shuttles 107
103. Net menders 108
104-5. Koko with umeke 113
106. Huewai 114
107. Olowai 114
108. Koko puupuu 115
109. Native with auamo 116
110-11. Piko A, Hanai C 117
112. Piko B, Hanai B 118
113. Hanai D 119
114. Piko C, Hanai A 119
115. Hanai F 119
116. Piko D 120
117. Piko E 120
118. Piko E, Hanai A 120
119. Piko F 121
120. Piko F, obverse 122
121. Piko F, reverse 123
122. Piko F 124
123. Piko G 125
124. Piko H 126
125. Piko J 126
126. Piko J 127
127. Piko K 128
128. Piko L 128
129. Piko M 129
130. Piko N 129
131. Piko N, Hanai G 130
132. Piko O 131

PAGE
133. Piko O, Hanai D 131
134. Hanai A+B 132
135. Hanai B 132
136. Hanai C, Piko D 133
137. Hanai D 133
138. Hanai E 134
139. Hanai F 135
140-1. Hanai G 135
142-3. Hanai H 136
144. Hanai H+J 136
145. Hanai J 137
146. Hanai K 137
147. Hanai L 138
148. Hanai M 140
149. Foreign bag 141
150. Technique of foreign knot 142
151. Hanai of plain knitting 142
152. Samples of koko 143
153. End of auamo, showing pu uo 144
154. Detail of aha hawele 147
155. Huewai pueo with aha hawele 148
156-7. Huewai with aha hawele 149
158-9. Ipu lei 150
160. Poho aho, with cords 151
161. Huewai with cord handles 151
162. Gourd umeke with cords 151
163. Commencement of a net 153
164. Sample of .4 inch mesh 159
165. Diagram of upena nae kuku 161
166. Hano ohua 162

Mat and Basket Weaving of the old Hawaiians, with illustrations of similar work from other parts of the Pacific. By William T. Brigham, *Director of the Bernice Pauahi Bishop Museum.*

In this essay I shall endeavor to show the Mat and Basket Work of the Hawaiians, carrying the study of the textile work into the netting, of which the people made great use, not only for fishing, but for carrying *umeke* or bowls, and as a foundation for the feather work already described.[1] All this is essentially the work of a primitive people. Hand-made mats, baskets, nets are found everywhere among savage races in one form or another, and however perfect the handicraft, however beautiful the form or decoration, we recognize the process as of a lower order of civilization. And yet there is a flavor of humanity in this simple work of untutored man that the mere mechanical products of the loom or knitting machine can never show. In the whirl and rush of the twentieth century there is little time for the natural work of human hands fashioning a basket, plaiting a mat or knotting a net; the people who can only make these things as their ancestors did long generations ago are passing off the stage, and the inanimate machine, the modern slave of civilized man, is doing this work,—but in how different a way!

Will the baskets of the Amerind, which now sometimes bear a valuation of several hundred dollars, be fairly replaced by any machine-made product? Will any loom put out such fabrics as the old Niihau mats, each one the work of years? It is the same with other hand-made fabrics. The Kashmir valley, where the songs of the weavers on the banks of the Jhelum are translated into harmonious design, may still smile at the fabrics of the steam-driven and ingenious looms of Jacquard in sunny France. The individuality is lost in the multitude. Can the most perfect productions of chromatic printing show to the critic the touch of the master whose work has been copied by many and intricate processes? When mats are produced by the yard, baskets by the thousands, and nets by the mile, artistic interest departs from them and we look only to their utility. Does not the father look with truer pleasure upon the first ungrammatical, misspelled composition of his child than upon the correct and finished writing of his maturer years?

Human nature also delights in rarities, and aboriginal mats and baskets are fast becoming few in number as their makers are "civilized" from off the earth. We have fragments of baskets and mats from the Egyptian tombs of early dynasties, and wonderfully woven cloths from the *huaca* of ancient Peru; but where, outside of a few museums, are the mats and baskets of a majority of the tribes of Amerinds? I do not know of a single specimen of old Hawaiian basket in any of the principal museums of the world,—the only complete specimen that survives is in the Bishop Museum.[2] The art is wholly lost to the Hawaiians and their choicest mats are now very rare. Basket making of the choice kind ceased on these islands many years ago, and another generation will have forgotten how to make *makaloa* mats. The subject then of aboriginal basket and mat making is growing in interest and importance, and even the islands of the great ocean can contribute to its history.

---

[1] Memoirs B. P. Bishop Museum, Vol. I, No. 1.

In Polynesia there was no loom, for the pegs and bars used by the Maori of New Zealand to assist in weaving his mat of "flax" (*Phormium tenax*) do not deserve the name. Cloth was generally replaced by paper, commonly called tapa or bark cloth, from Rapanui to Kauai and across the ocean westward. All along the northern and western boundaries of Polynesia the islanders had looms, and, as we shall see later, those of the Caroline and Santa Cruz groups were sufficiently developed to turn out admirable products. If the proto-Polynesians came from Asia they saw a fence of looms across every possible path from thence to the Pacific. On all the islands where they settled there are and have been cultivated the paper mulberry (*Broussonetia papyrifera*), hibiscus, banana and other fibre-plants used more or less in the textile processes. The material was at hand, but with the exception of the Maori, whose climate forbade, Polynesians preferred to felt their fibres rather than weave them, although they all understood the process of extracting these fibres as in the hibiscus mats of the Samoans, the oloná cord of the Hawaiians, and the sennit of coconut husk fibre of Polynesians generally. That they made fairly good use of their knowledge, apart from the loom, I shall endeavor to show by the work of the Hawaiians and, so far as material is at my disposal, of other Polynesians and their neighbors with whom they had in ancient times more or less communication.

All through Polynesia the immigrants found vegetable products very fit for basket or mat making. Whether on some of the groups certain plants were brought with the immigrants or preceded them in colonization need not be discussed here. Everywhere they had, even during the period of their legendary history, the hala (*Pandanus odoratissimus, et al. sp.*) of which the leaves were used for both mats and baskets, and the fibres of the aerial roots for sandals and baskets; coconut (*Cocos nucifera*) whose fibres they twisted or braided, whose leaves they made into baskets, mats and fans, and whose rootlets they used to plait into fish baskets and traps; waoke

---

[2] Several of these baskets have long been in use in Honolulu families, but almost invariably without the cover that properly belongs to them, as we shall see below. One, added to the Museum collection since the above was written, was in use for fifty-five years by the giver.

(*Broussonetia papyrifera*) whose fibres were beaten into kapa or twisted into strong cord; hau, fau, hibiscus (*Paritium tiliaceum*), whose bast yields a strong fibre used for mats and cords; and banana (*Musa var. sp.*), of which the fibres are of many grades, used chiefly for fine mats and belts.

The Hawaiians had in addition ukiuki, a thick-bladed grass whose leaves were braided into sennit to tie together the beams and rafters of the native house, *hale pili:* makaloa (*Cyperus lævigatus*), a sedge from whose tender stems the fine Niihau mats were woven; oloná (*Touchardia latifolia*), invaluable for its tough and durable fibre, from which were twisted cords for fish lines, nets, etc.; mamaki (*Pipturus albidus*), used mostly for felting into coarse, tough kapa, but also for cords and ropes; ieie (*Freycinetia arnotti*, and in Tahiti *F. demissa*), from whose aerial rootlets the choicest and most durable of the Hawaiian baskets were made; iwaiwa, several ferns from whose stems were plaited fish traps and baskets. Other fibrous plants of less extensive use will be noticed as they occur.

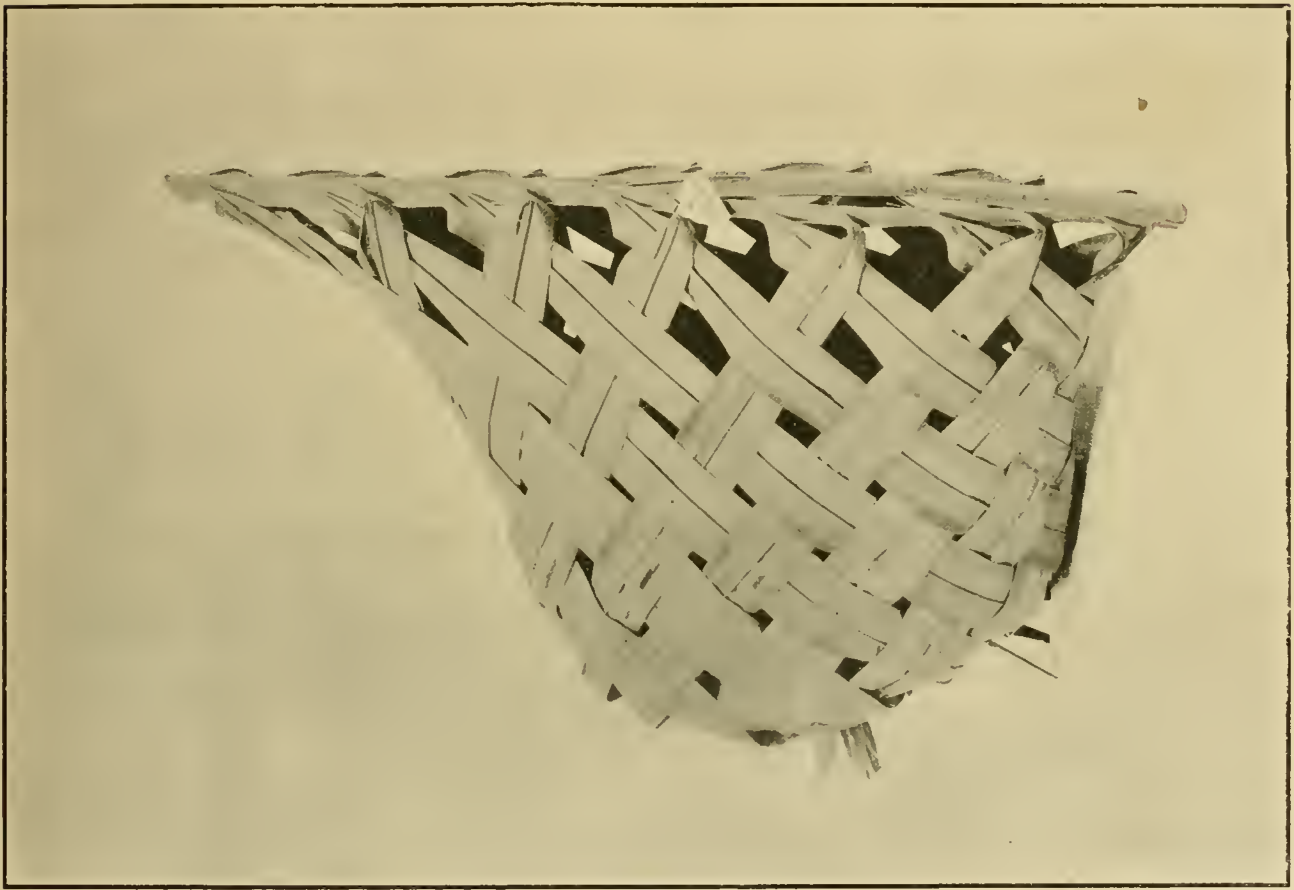


FIG. I. COCONUT LEAF BASKET.

With this wealth of material, mostly growing wild, but in some cases, as waoke and oloná, cultivated for convenience or to improve the quality, it is not strange that the islanders made their clothes (scanty indeed, but sufficient), their beds and pillows, carpets and house linings, baskets, shoes and hats, fish lines and nets, sennit, cords and ropes of the varied form and quality we are to consider in this chapter. While the use of some of these fibres for felting in the interesting manufacture of paper (kapa), for which Polynesians are celebrated, must, from its importance, be treated in a separate chapter, the other uses of a textile nature will be treated here, arranged for convenience under the following heads:—

PALM LEAVES AND FIBRES.—Baskets, Fans, Sennit, Hats.
PALM STEMS.—Shields.
PANDANUS.—Hats, Mats, Pillows, Baskets, Sails, Mat Garments, Cord (covered), Fijian Basket.
FREYCINETIA ROOTS.—Baskets.
FERN STEMS.—Baskets, Fish Traps.
GRASS.—Makaloa Mats, Rush Mats, Cord, Bambu Fans, Combs, Spears and Clubs.
SANDALS.
AUSTRALIAN BASKETS.
HIBISCUS FIBRE.—Mats of the Samoans.
BASKETS OF MAORI.
BANANA FIBRE.—Looms of the Caroline Islands, Caroline Dress Mats.
OLONA FIBRE.—Nets, Koko puupuu.

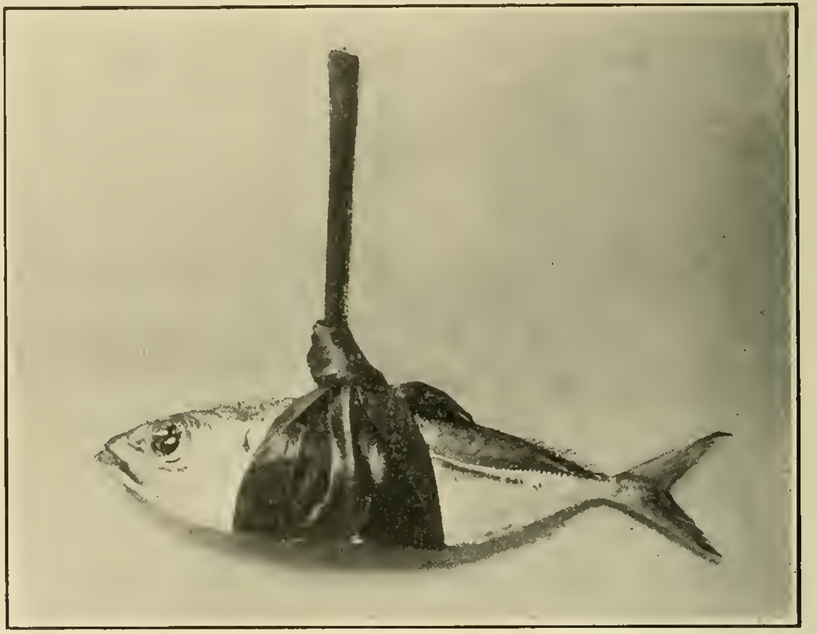


FIG. 2. HAWAIIAN KI LEAF BASKET.

While the order here indicated may in cases be departed from, the subjects will all receive attention and the general order will be preserved. It is an arrangement by material rather than by product.

Whether mats or baskets were first invented may not be definitely settled; nor is it of importance here where we are not treating of general manufactures, but only of special products in a region where man did not begin at the bottom, but came into the land armed with certain implements and a partial civilization. If it be necessary to explain why I begin with the latter, rather than the simpler mat, I would ask my reader to try to divest himself of all misleading facts of civilization as we know it, much as one does partially when camping in wild countries, or in living in this very Pacific region. He makes a hut of branches, he spreads a bed of leaves, but to gather the leaves as the birds do would be tedious and the night far gone before the couch would be comfortable; and he needs something which would answer to a basket although he can do without a mat. We are supposing him without clothing (in the fashion of the region), so he can neither use his hat nor his handkerchief. He might have been wrecked on a desert island without the very convenient concomitants of the Swiss Family Robinson, and to gather his simple food, whether roots from the ground, nuts from the trees, or fish from the sea, would a mat or a basket come best to hand? To preserve his little hoard would he prefer a basket or a mat? But a basket is a more complicated bit of work than a mere flat mat. Perhaps some baskets are truly more difficult to make than are some mats; but here is one (Fig. 1), common enough throughout the tropical world, which is as simple as can well be imagined, and, while an efficient basket, also suggests how to make a mat. The fresh leaf of the coco palm is always at hand and the suitable section of midrib is cut off from the long (10–12 feet) leaf and the leaflets braided together around whatever the basket is to hold. The strong midrib is the handle, and to open the basket it is only necessary to split this, an easy operation. The particular basket here figured came to me from Manila filled with delicious Manila mangoes—thanks to Lieutenant-Commander George M. Stoney of the U. S. Transport Solace—but similar rude baskets are made everywhere, and the traveler buys them at Suva or Apia filled with coral, and in some islands the carpenter or mason brings his few tools in a similar kit. Another that came to this Museum filled with madrepores is shown in Plate IV, the upper left-hand figure. The only simpler carrying machine of the nature of a basket known to me is the Hawaiian ki leaf (*Cordyline terminalis*), which is simply wrapped around a single fish (Fig. 2); or, if a number of articles are to be carried, as oranges or limes, a stem of leaves, each leaf

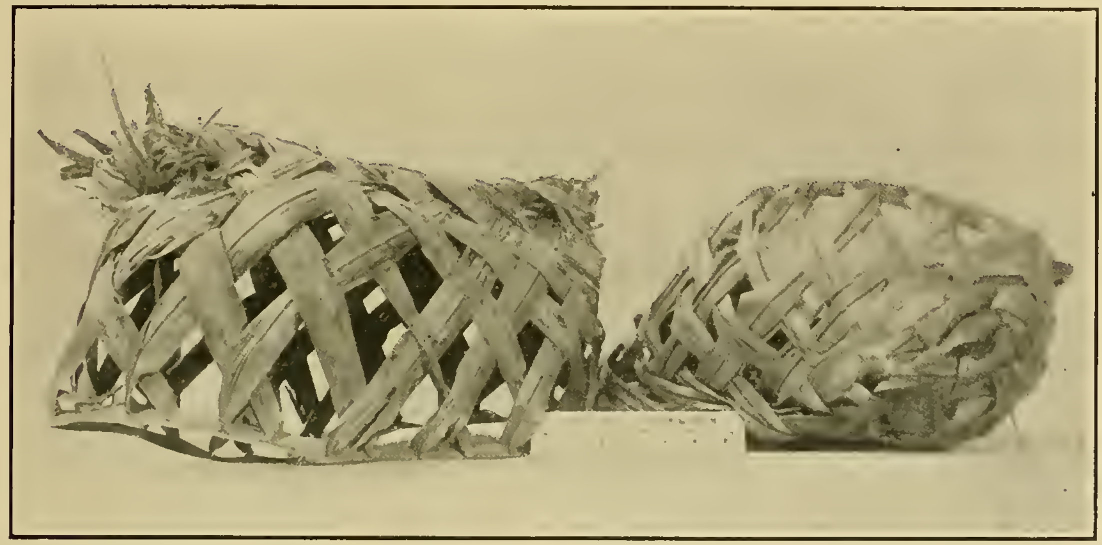


FIG. 3. COCONUT LEAF BASKETS FROM TUTUILA.

enwrapping a single fruit, makes a substitute for basket.[3] There are some satchel-like baskets (see Pl. II, Gilbert Island Basketry) that seem to be a folded mat, but on the other hand the basket may suggest a mat when it becomes ragged and broken open.

To study the evolution of a coco palm leaf basket we draw the material naturally from the central Pacific where the *Cocos nucifera* flourishes, and is indeed the principal tree of the low coral islands. Figure 1 shows a neat primitive form, but the more common of these simple baskets is much ruder and is used universally in bringing *copra* (the extracted meat of the ripe coconut) to the storehouses, for collecting fish and coral, and for many other purposes. In this Museum are Nos. 6592-93, which were brought full of coral from Pagopago, Tutuila, of the Samoan group (Fig. 3); and No. 5631, from Ponape of the Caroline Ids. (Plate I, left-hand upper.) Photographs in the Museum show precisely similar forms from Tonga and elsewhere in the coconut region. Baskets of this class are limited in size by the leaf of which they are made. In Fig. 1, No. 5621, the length of the top strip is 17 in., and from this the depth of the basket is 11 in. No. 6592 is formed of a split strip 35 in. long, bent end to end; No. 6593 has a similar strip 47 in. long: while No. 5631 is composed of four split strips, each about 10 in. long and with six leaflets, woven simply together, the ends of the leaflets being brought up the sides and tied together to form a handle (not shown in the figure). The last basket measures 16×13 in., with a depth of about 8 in.

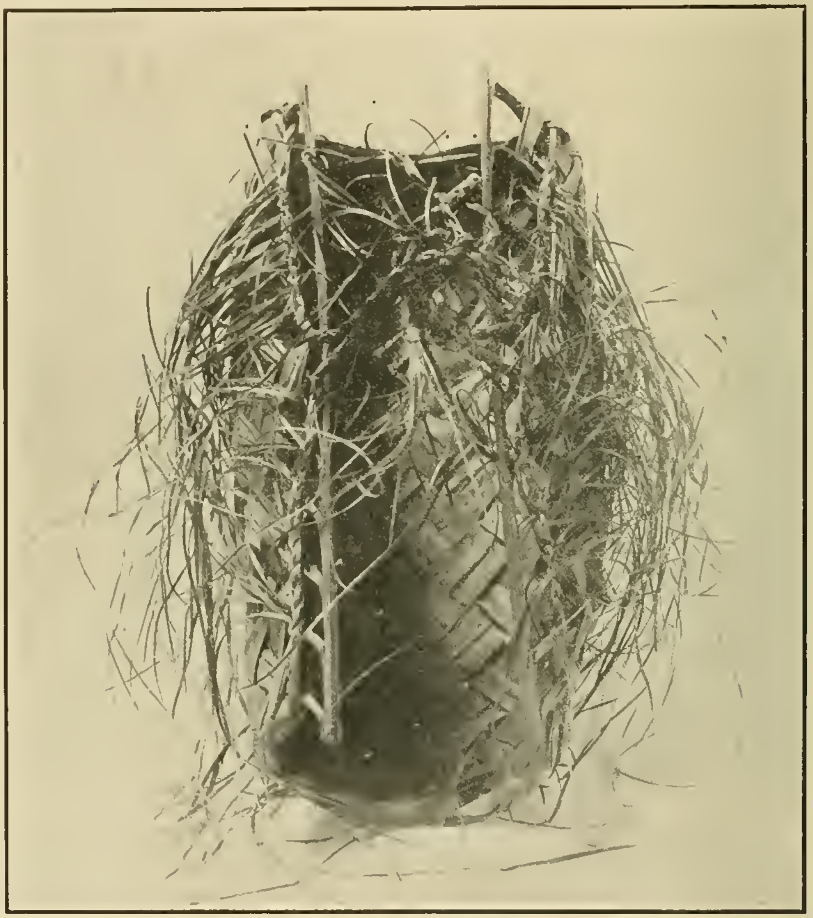


FIG. 4. COCONUT BASKET FROM SHORTLAND ISLAND.

---

[3] Hon. S. B. Dole, in reading proof, reminds me that Hawaiians also tied the ends of the leaves together to make a sack for carrying ohia ai (*Eugenia malaccensis*).

It seems perfectly just to point to this type as the earliest form of basket, although made at the present day, no ancient specimen existing, at least from the region we are considering. The perishable nature of the material; the roughness of the workmanship; nay, the very abundance of specimens would account for their rarity or absence from early collections, for these were mostly made not for scientific purposes, nor to illustrate the life history of the natives, but simply as "curios", matters of oddity or rare workmanship. The series cannot be worked out from exclusively Hawaiian material because the coco palm, here near its tropical limit, does not grow freely nor develop luxuriant leaves: the pandanus was here the more important tree for the purposes of basketry as well as for mats, and the fashion of the basket and mat both partook of the peculiarities of material. We must turn then to the central Pacific for our illustrations.

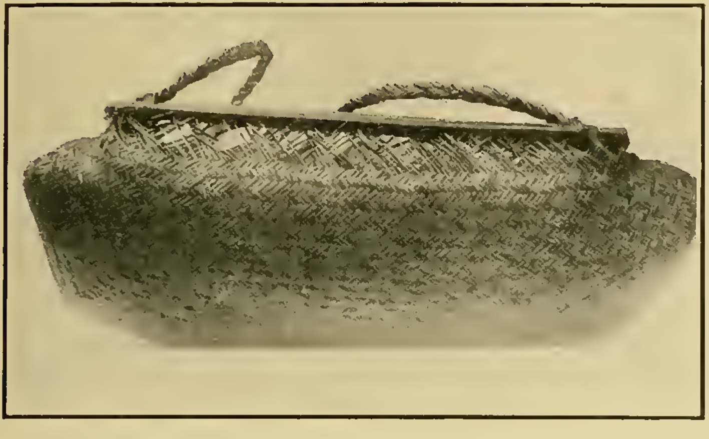


FIG. 5. PALM BASKET FROM PONAPE.

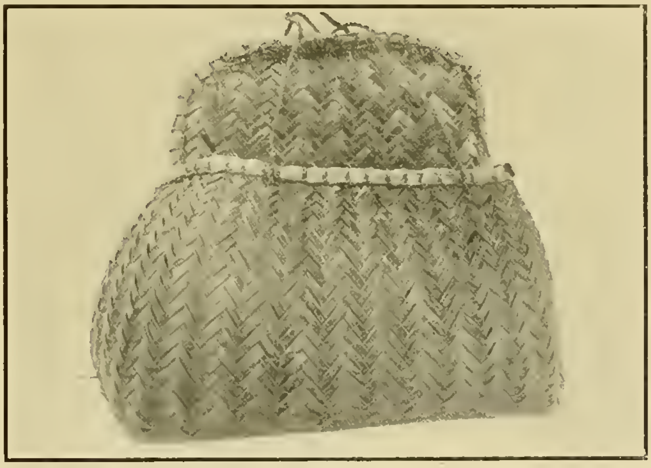


FIG. 6. COCO LEAF BASKET FROM THE CAROLINES.

Looking again at Plate I, next to the rude coconut frail, No. 5631, is a far finer basket, which at first glance seems to have little connection with its humble neighbor, but the curious form No. 8302, from Shortland Id., of the Solomon group, may prove a connecting link. Here we have the split midrib 15 in. long, with eleven leaflets on each half, and these are neatly and closely plaited, the leaves overrunning at the edges and brought back to the midribs where they are split and a portion braided into short loops for handles, the rest finely shredded for an ornamental fringe. Does

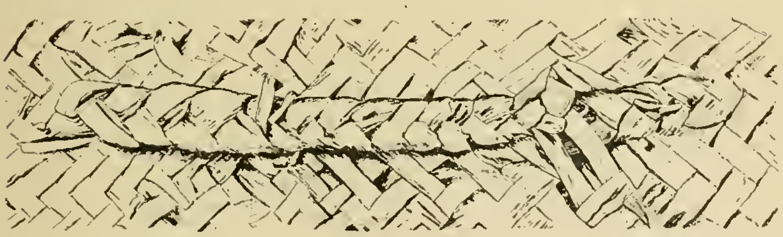


FIG. 7. CLOSURE OF BASKET BOTTOM.

not this chalk out in rough outline the far better finished basket of Ponape? (Fig. 5.) Here are the midribs 12.5 in. long, but instead of one there are eight on each side; that is, one is split into eight distinct pieces, and the portion of leaflet adhering to each is halved, each half passing in opposite direction in the weave, which is finer and twilled (three-leaf twill). The palm seems also to be of finer texture than the cocos, but is probably a young leaf. The edges or ends are continued in the weave so that they form a continuous side, meeting at the level of the midribs, as shown in the plate.

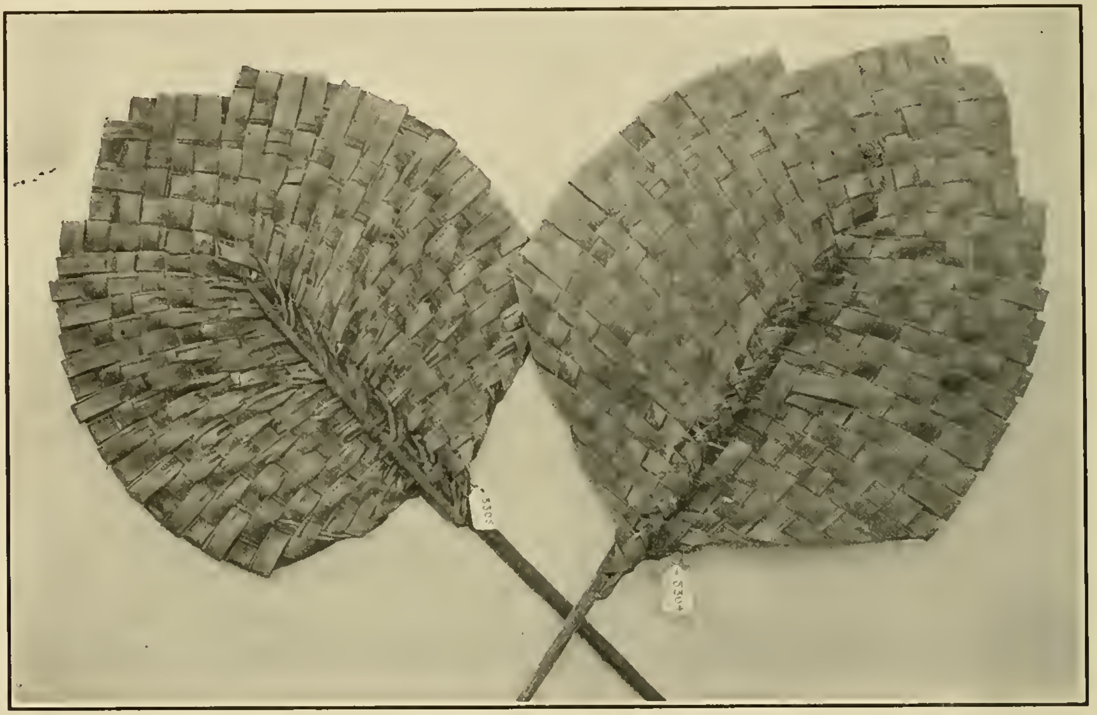


FIG. 8. FANS FROM THE SOLOMON ISLANDS.

The small rectangular basket, No. 7800, also from Ponape, shown in the corner of the same plate (II), measures only 5×3.7 in. at the mouth and is about 2.2 in. deep. While the material, coco leaf, is the same as used in the last example the structure is different. The twill is three-leaf and arranged so that a triple band passes like a keel through the length of the basket; similar bands pass from each corner of the rim and turn horizontally at the bottom, while the rest of the weave is at right angles to these bands. At the top the ends of the strips are turned alternately in and out over a rim of sticks which is beautifully and with great regularity sewn over and over with a two-ply thread apparently of some fine grass. Handles of similar cord but three-ply are attached to the corners.

We may return to the coco leaf midribs to see how they are used in fashioning a complete basket, not only in the Carolines, but in very closely allied form as far east as the Gilbert group (No. 7518, not figured). In the Caroline basket, shown in Pl. II, and also more distinctly in Fig. 6, the same bits of midrib that we have seen in the simplest form of basket appear here again, in a somewhat degraded form it is true, but when the covered rim is stripped of its covering of leaf sewed over with coco cord there are the sections of midrib, four in number, as the woody tissue does not stand a sharp bend without breaking, and only enough wood has been left to hold the attached leaflets together and at the same time take the place of the sticks often used in such a place. The leaf strips are twilled into each other (two-leaf twill), forming a continuous surface not absolutely symmetrical, and the ends are braided into a ridge extending over more than half the length of the bottom, as shown in Fig. 7. This ridge serves to strengthen the basket and protect the bottom from undue wear. The cover is formed in similar way but with only one strip of midrib, and is attached to the basket

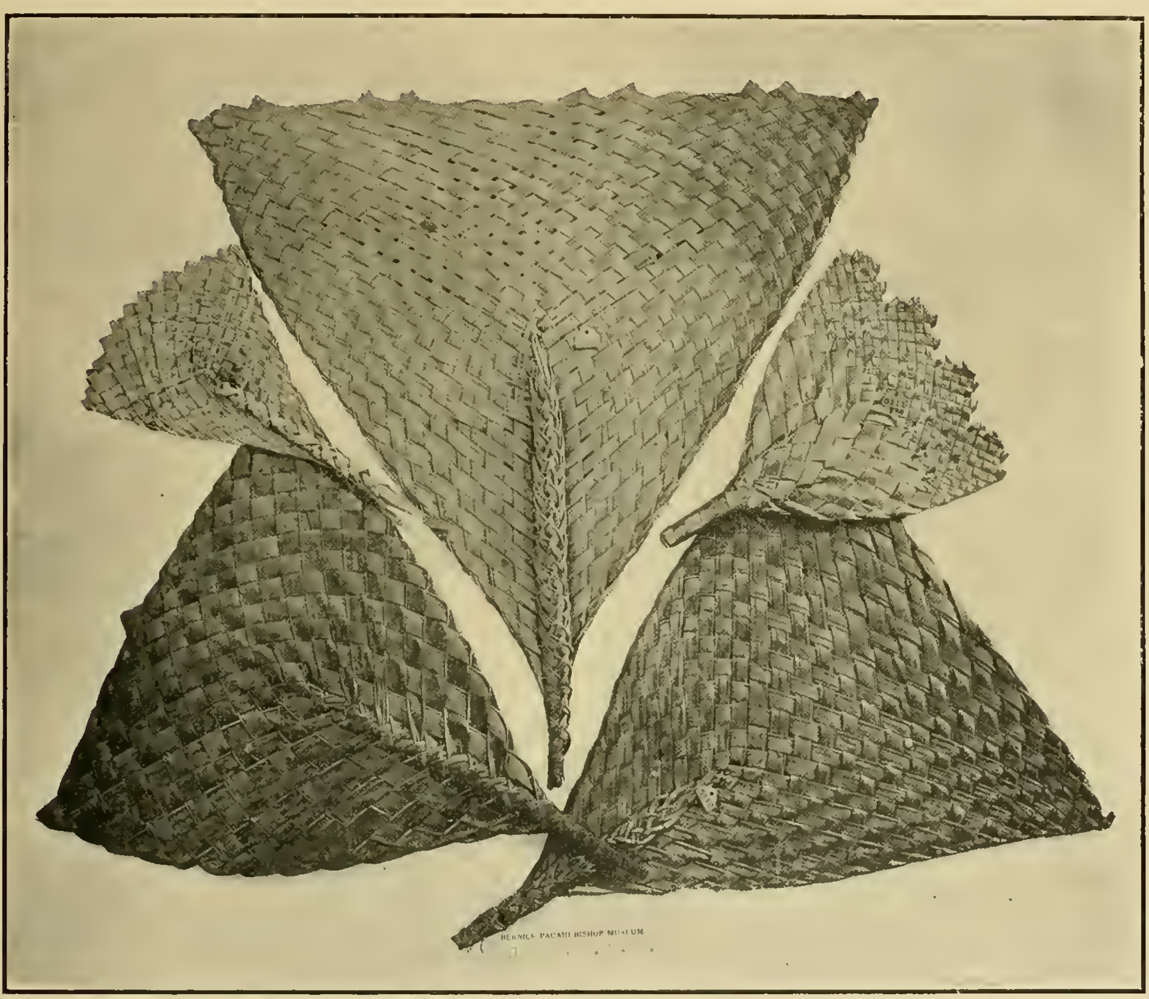


FIG. 9. HAWAIIAN COCO LEAF FANS.

not only on one of the long sides but for a short distance on both ends, apparently to keep the cover closed when not forcibly held open. The handles are of stout coco cord. In the Gilbert Ids. specimen, No. 7518, the form is more symmetrical, and the leaf used is lighter in color; otherwise the construction is identical.

The midrib structure appears again in the fans from Shortland Id., shown in Fig. 8. Two strips of a split midrib, each with six leaflets attached, are used in the weave; an additional portion of midrib stripped of leaflets serves as handle, the other midrib being cut off at the base of the blade. The workmanship is rude, by no means so neat as the Hawaiian leaf fans, but is effective. The blades are about 12 in. wide. Turning to the Hawaiian form of coco leaf fans (*Peahi niu*) we find a much finer elaboration of the same device. In Fig. 9 the fans, with the exception of the small one on the right, which is of pandanus leaf, are formed from a section of midrib not split, and the leaflets are deftly twisted over the midrib in a firm braid, the lower ones forming the handle without additional preparation, and the others with these gradually opening in the weave until the extent of the leaflets is nearly reached, when the ends are turned in, forming either a straight edge, or curved, smooth, or with serrations. Sometimes only one tooth appears in the middle. This form of fan is very practical and durable, and is much to be preferred to the more fanciful but modern designs shown in Plate XV. With the young leaves of the date palm the leaflets are often reflexed on one side instead of crossed (No. 5117). In modern times the leaves of some of the many introduced palms are used by the Hawaiians in the same way.

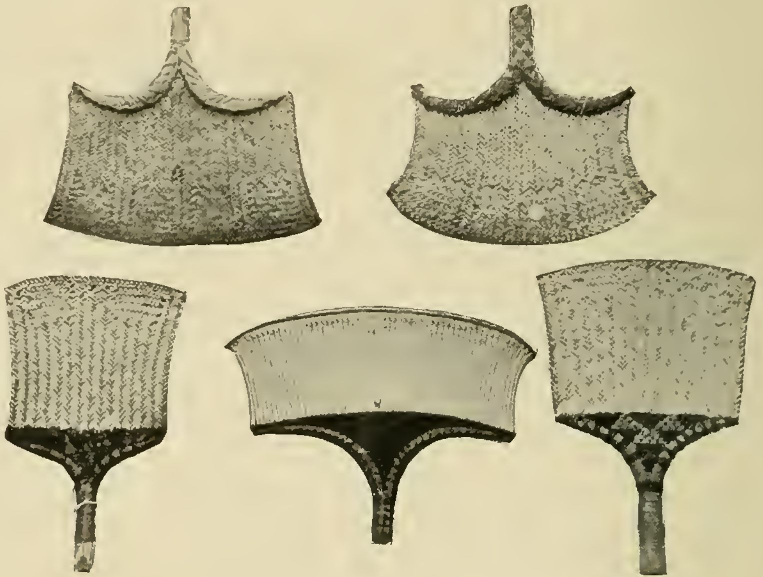


*FIG. 10. HAWAIIAN FANS IN THE BRITISH MUSEUM.

That fans were used by the old Hawaiians we learn from ancient *mele* or songs, and in the Song of Kawelo[4] occurs the following fragment:—

Papa o hee ia nei lae.
E u'alo, e ualo
Ua alo mai nei ia'u
Ka launiu e o peahi e;
E hoi au e, e hoi aku.

Go, daughter of Papa, away from
this headland;
Cease thy lamentations;
Cease to beckon to me with thy
fan of coconut leaves;
I will come again. Depart thou!

---

[4] Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands. Translated from the French of Jules Remy by William T. Brigham. Boston, 1868. (p. 41.) Also reprinted by Nordhoff in his California, etc.

A form of fan used by the chiefs before the advent of foreigners is shown in Fig. 10, representing a collection of Hawaiian fans in the British Museum. None of these are so useful as those shown in the preceding figure. I have not examined carefully these fans, which have, I understand, been in the British Museum for many years; but, from the specimen in the Bishop Museum, shown in Fig. 11, it is probable that some of them are of pandanus. In this last fan, which is very old and brittle, the form is not so useful as ornamental; the blade is closely and neatly woven; the spreading handle, which is the remarkable part of the fan, is carefully embroidered with human hair and some brown fibre. In many respects this work surpasses in design anything Hawaiian in the department of basketry. Only the Solomon Islanders, as we shall see later on, have done finer work of the kind in their grass embroidery. The use of human hair, whether of friend or enemy, was common in Samoa and Fiji as well as on Hawaii, but on the last group the hair was almost always that of some friend. Several of these fans are in the Museum of the Peabody Academy of Science at Salem, Mass., most of them of good form. These were in the old Marine Museum early in the last century. I have never seen any of these old time fans in private collections on these Islands.

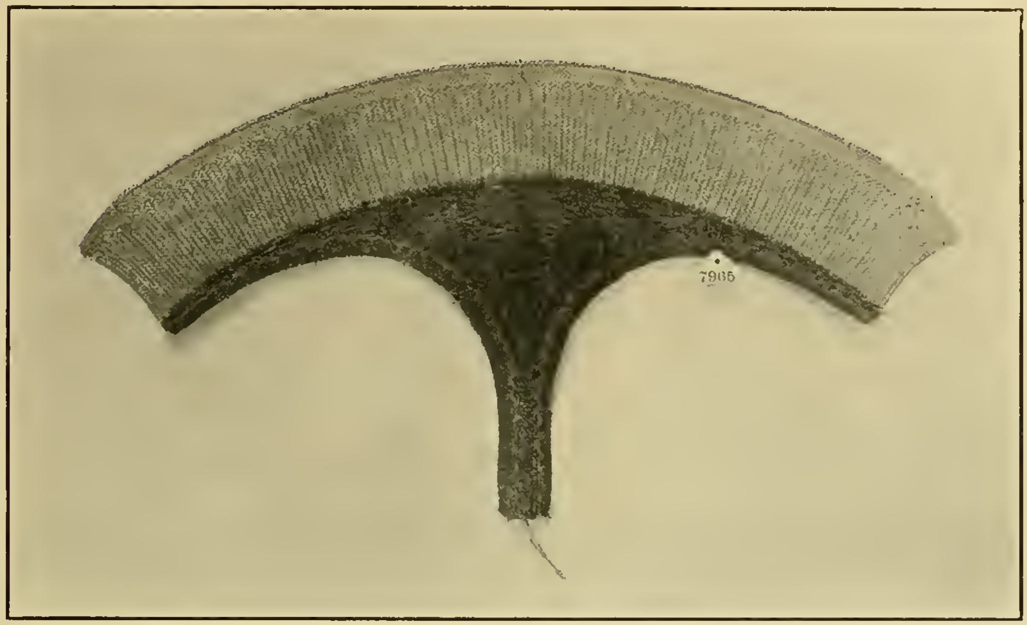


FIG. 11. ANCIENT HAWAIIAN FAN. BISHOP MUSEUM.

In all countries where the coco palm abounds considerable use is made of the leaves for walls, fences, fish weirs, screens, etc. Two leaves, or more commonly the halves of a leaf, are placed with the split midrib outward and the leaflets rudely interwoven. The sides of tropical houses are often made of this rustic paneling, and on the Hawaiian Ids. it is a favorite construction for sides and roof of temporary verandahs or lanai.

Before leaving the coconut fans a point in their construction may be noted. While the method described where the fan grows from the midrib is the common one, and perhaps the most natural one, there are often loose leaves that may be used for the purpose, and then the fan is started at the outer rim as a mat would be, and constantly narrowing the weave the ends are at last braided together to stiffen the blade and gathered to form a handle. This structure is shown in Fig. 12, and may be termed the centripetal, while the former is the centrifugal system. In the illustration the first fan is Hawaiian and made of pandanus leaves; the second is also Hawaiian but made of palm; the third is from the Marshall group and is of coconut leaf, the handle neatly plaited with coco cord and edged with pandanus and hibiscus; while the fourth is from the Carolines and well woven from palm, but was covered on the edge coarsely with foreign cloth.

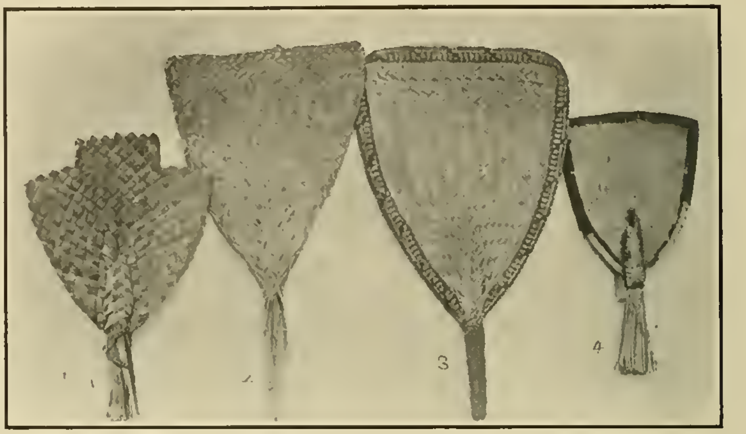


FIG. 12. VARIOUS FANS.

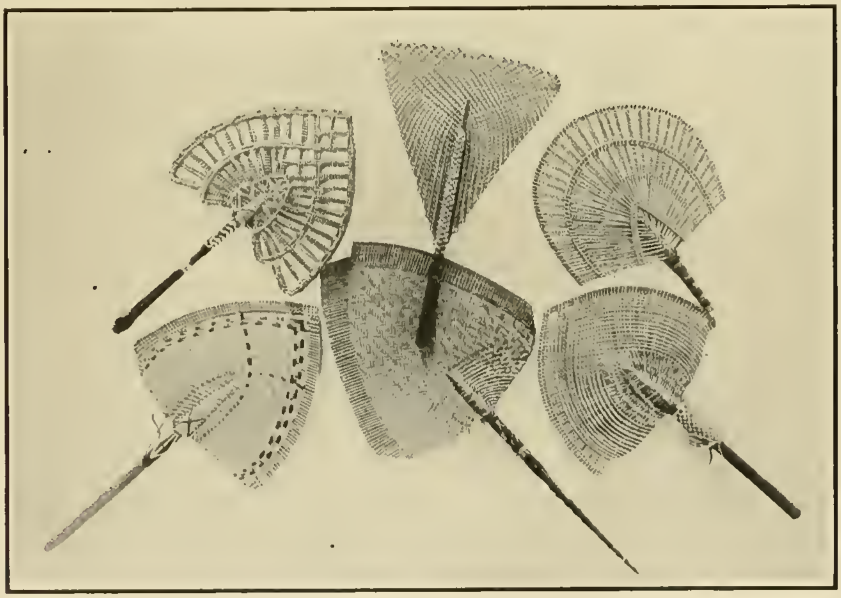


FIG. 13. SAMOAN FANS.

Samoan Fans.—To those who have only seen the skeleton form of fans usually purchased by travelers, or sold in the curiosity shops, the variety of form and construction of Samoan fans (*ili*) is surprising. Take, in the illustration (Fig. 13), the central triangular fan which recalls the common Hawaiian form, but is of entirely different construction. In the Hawaiian fan, it will be remembered, the weaving is uniform and the leaves themselves serve for handle; in the Samoan the weave is on a trellis, as it were, and the strands are very narrow, the handle is of wood braided in afterwards; it is a good substantial form. The curious way in which the edge strands are bent to cover the ends of other strands is shown in Fig. 14. Directly under this fan in the previous figure is one of considerble surface ending in a square trellis border, also shown in the figure of enlargements on the left. The handle is carved, as was generally the case in the better class of fans in the Society and Hervey Ids., and rather clumsily inserted, the ends of the central strands being bound to the shaft by a fine cord of human hair, that popular ornament in the Pacific.

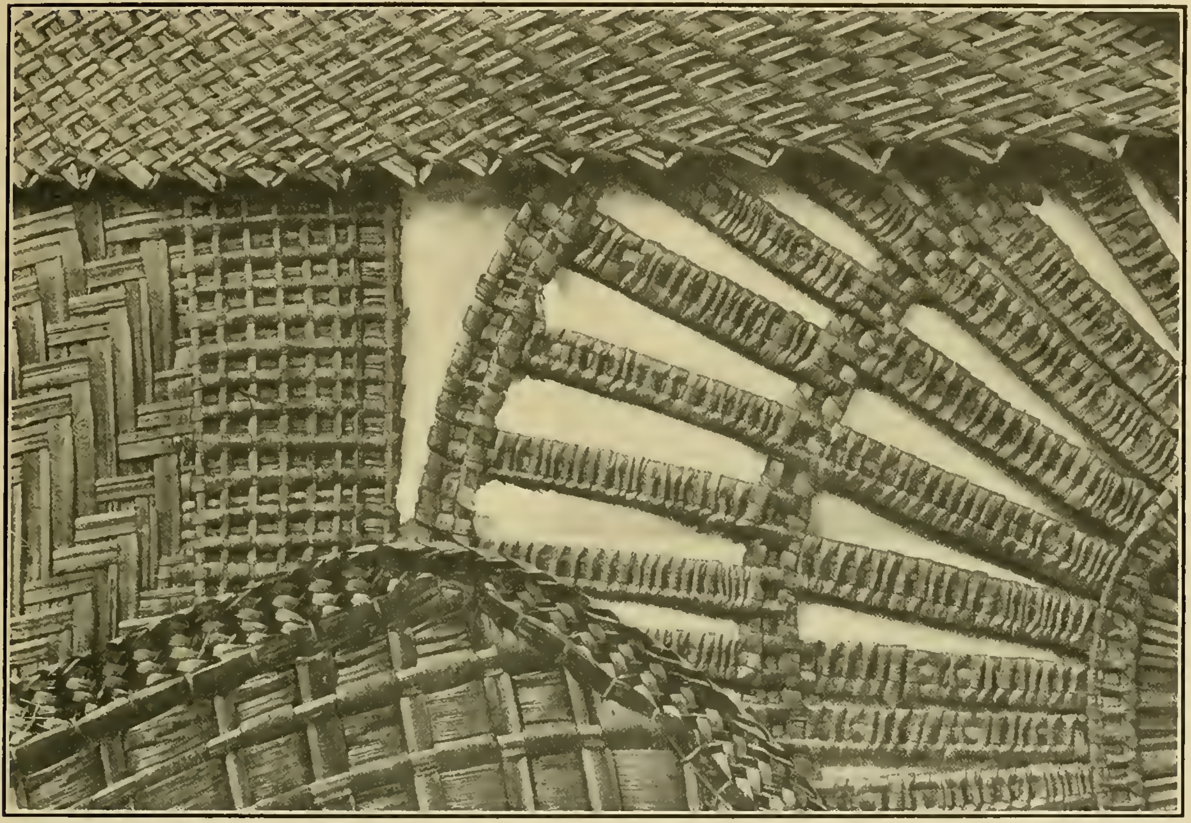


FIG. 14. ENLARGED FANS TO SHOW STRUCTURE.

In No. 2139, on the right of the triangular fan (Fig. 13), is a horseshoe-shaped skeleton fan which raises more wind than its open construction would promise. For handle the strands are bound together with sennit, and the general construction is shown on the right side of Fig. 14. On the other side of Fig. 13 is a pointed form, perhaps more common than the round. The other forms in the illustration need no especial description. As in almost all Pacific groups the modern manufacture shows a marked deterioration from the ancient standard, and in Samoa the use of other material than palm leaves, and the employment of tawdry dyes together with much less care in weaving mark the modern product.

Fijian Fans.—Rather coarse, clumsy, but at the same time durable and effective are the fans shown in Fig. 15. I do not claim that this is the only form in use in the Vitian group, where the work in carving and sennit is particularly good, but it is the only form of basket work fan that happens to be in this Museum,[5] and it is noteworthy for a peculiarity of structure. Several strips of the coco leaf are laid together on the upper edges to form a rim, and from these the two-leaf twill weave passes to the base where the ends of the strands are collected for a handle which is braced by braids on both sides of the fan and is wound with sennit. In both fans four strands of dyed leaf are introduced for ornament.

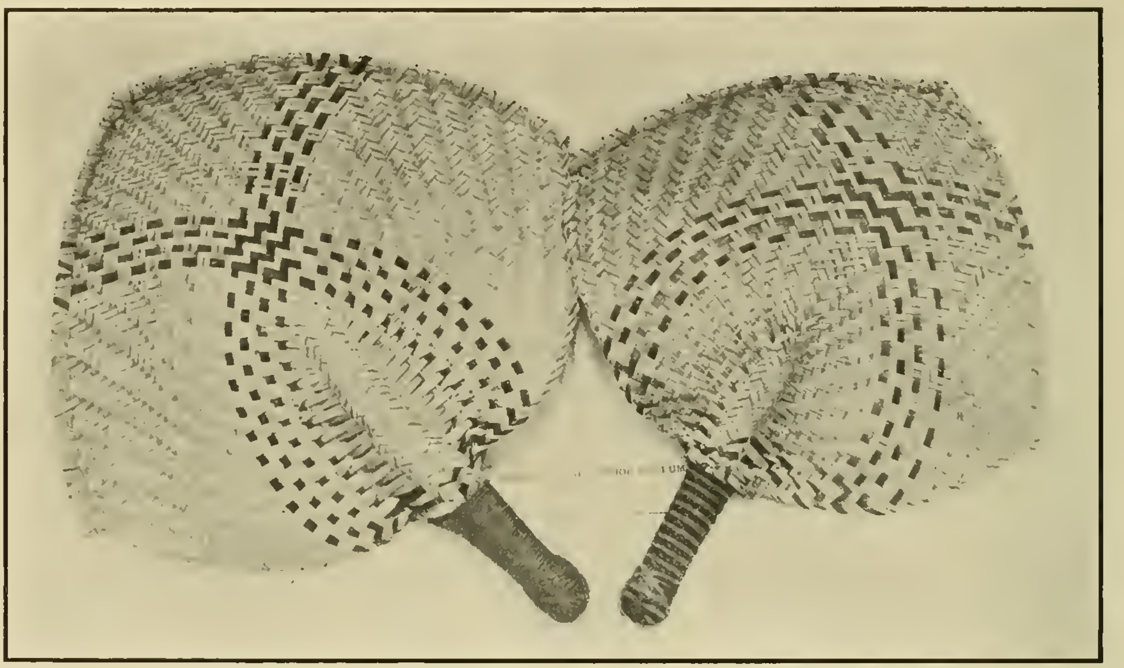


FIG. 15. FIJIAN PALM LEAF FANS.

Marshall Islands Fans.—In Fig. 16 are shown but three fans from a group where basketry flourishes and mats are made of remarkably good design and workmanship, as will be seen later on when fabrics of pandanus have their turn. To this later page must be referred the central specimen of the group which is of thin pandanus mat embroidered with red and black fibre. The mat is double and a stick is inserted for handle and covered with brown and black mat work of the same material as the body of the fan.

[5] There are kapa and tortoise shell fans in the Vitian collection.

While all the Marshall Islands fans do not have a border, this is certainly a very common appendage and is shown on all three fans in the illustration. The two specimens on the sides are woven in the trellis method as may be distinctly seen in the lower specimen of Fig. 14. The trellis is of the midrib of the coco palm leaf and leaf strips are woven into this framework, making a strong, stiff fan. The border is sewn on over a fibrous strip with fine coco cord, and the bundle of midribs, continuous with the blade of the fan, is covered with mat work as in the first specimen, the black here being some kind of bast, probably hibiscus dyed black with mangrove fruit.

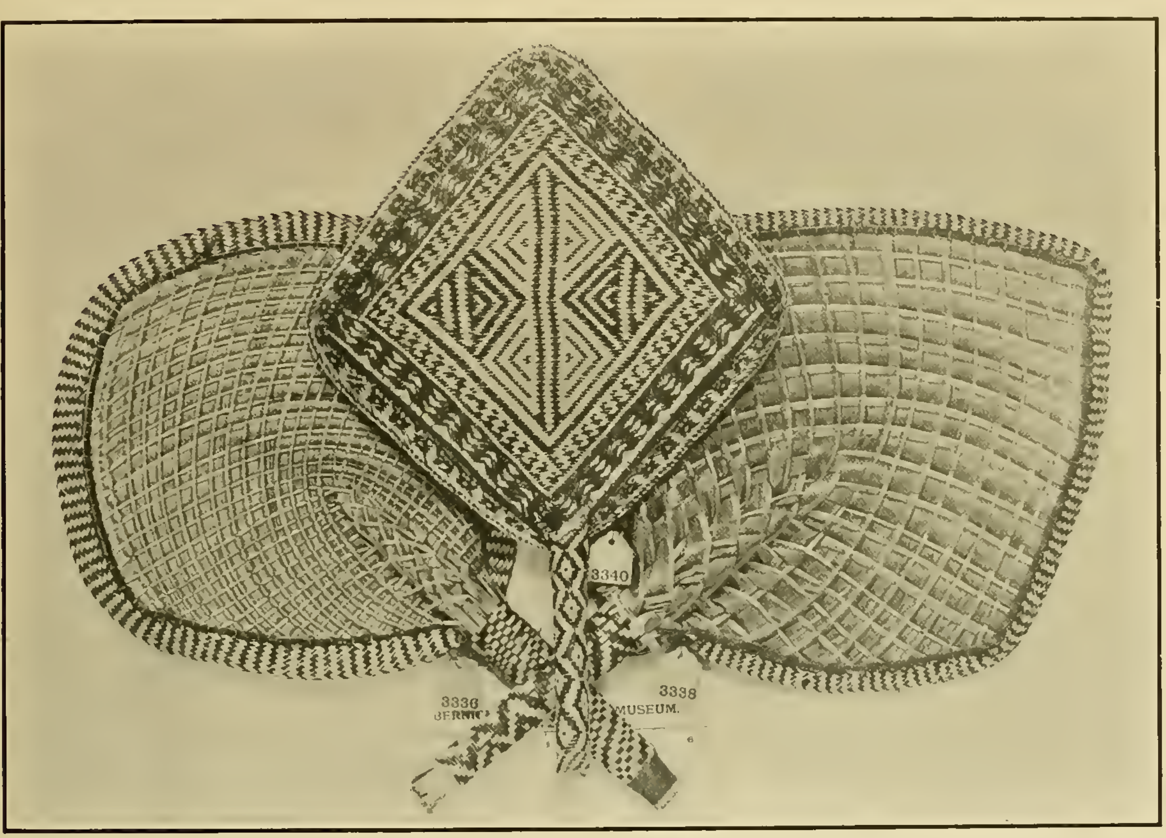


FIG. 16. MARSHALL ISLANDS FANS.

Not only the warm temperature but also the flies, which are a great pest on some islands of the Pacific, make fans a necessary implement for comfort, although the Samoans and other islanders used a fly-flap made of coco fibre mounted on a handle, and the Hawaiians used the feather kahili of small size for that purpose; and certainly the development of the fan industry merits a more generous treatment than can be given where only the basket work class can be used for comparison with similar work of the old Hawaiians, but a large collection of the fans of the Pacific has yet to be made, and even the old museums which have the most of the relics of old Polynesian handicraft have few fans. The use of fans as insignia of rank, so common in southeastern Asia, and seen also in the flabelli of papal display at Rome, does not seem to have had much vogue among the scattered islands of the great ocean.

The attraction of evolution has led us from baskets to fans, but we must now return to another form of basket made from palm leaf and wholly unconnected with the "midrib structure". No. 3346, in Plate I, is a coiled basket of palm from the Caroline Ids., looking at first glance like a rattan basket; but it is from the leaf and not the stem that it is constructed. To show the coils and the methods of binding these together Mr. L. G. Blackman has drawn for me two figures (19-20) and from these the entire structure of the basket may be seen;—the neatly sewed rim, the knots between each coil, the many sticks that compose this coil, and in the second diagram the curious displacement of what seem to be direct vertical lines of strip binding the coils. With these the curious reader can follow the construction, which certainly differs greatly from that of any basket belonging to the Hawaiian group, and it seems to show traces of a Malay origin, as do so many things and people of the Caroline archipelago.

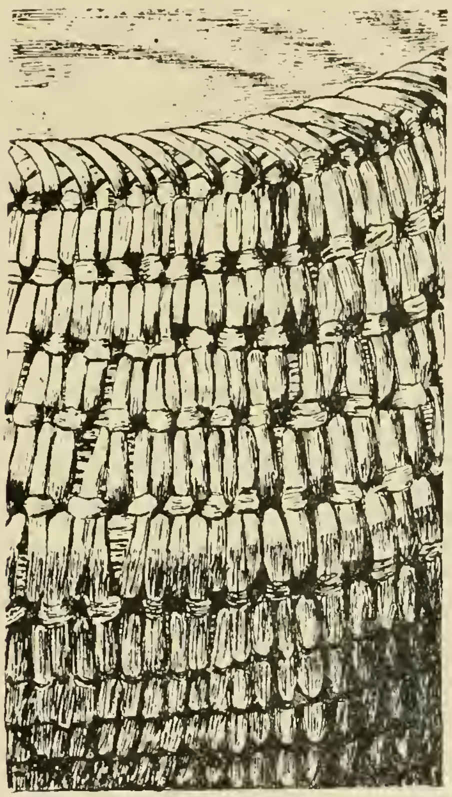


FIG. 19. CAROLINE IDS. BASKET.

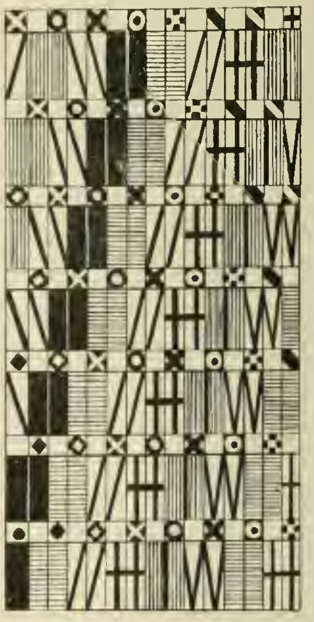


FIG. 20. COURSE OF STRIPS.

Solomon Islands Shields.—There are several plaited shields in the Bishop Museum, but one, No. 1859 (Fig. 21) is of very remarkable construction. A framework, 33×10.5 in., of rattan, light colored and rather soft but heavy, pared down flat, is covered with a fine weaving of rattan strips, the edges being bound by a braid of the same. Around the curved portions, top and bottom, is a border of pandanus strips about 0.25 in. wide, dyed red, folded over on the inner edge of the front of the shield, and the corners of the fold trimmed off so as to leave enough of the leaf to hold the two parts of the strip together. As shown in the illustration (Fig. 21), there is a decorative figure woven in black strips of the same material at top and bottom of the shield. Both sides are woven alike, including the black figures, but the inside has a covering of broad (5.5 in.) leaves of the pandanus. The decorations are very remarkable, consisting of twenty-three shell rings ⅞ in. in diameter in two transverse bands, and 3677 smaller shell rings or beads disposed in bands and pendants. The main bands are wholly of white shell, while the pendants are white, red (*Spondylus sp. ?*) and black, the latter of some vegetable matter at first thought to be coconut shell, but later, some marine growth. The bands are sewed with, and the tassels of the pendants strung on fine cord or coarse thread made of two-ply hibiscus fibre. The tassels of the pendants are tipped with perforated, elongated, pointed, black seeds with a hilum extending almost the entire length. Most conspicuous over all extends a cruciform figure composed of fifteen rosettes of red, black and yellow feathers. This cross seems purely geometrical and not an introduction of some missionary, for at the time this was obtained no missionary had landed on these shores since Mendaña raised the cross and took possession for Spain, and we read that the crosses he erected were at once destroyed by the natives.

When it is considered that the several thousand shell rings had to be bored with a rude pump drill, then strung in numbers on a tough midrib and rolled between stones until round, it will readily be admitted that the great value the islanders attach to such a shield is justified. Two other rattan

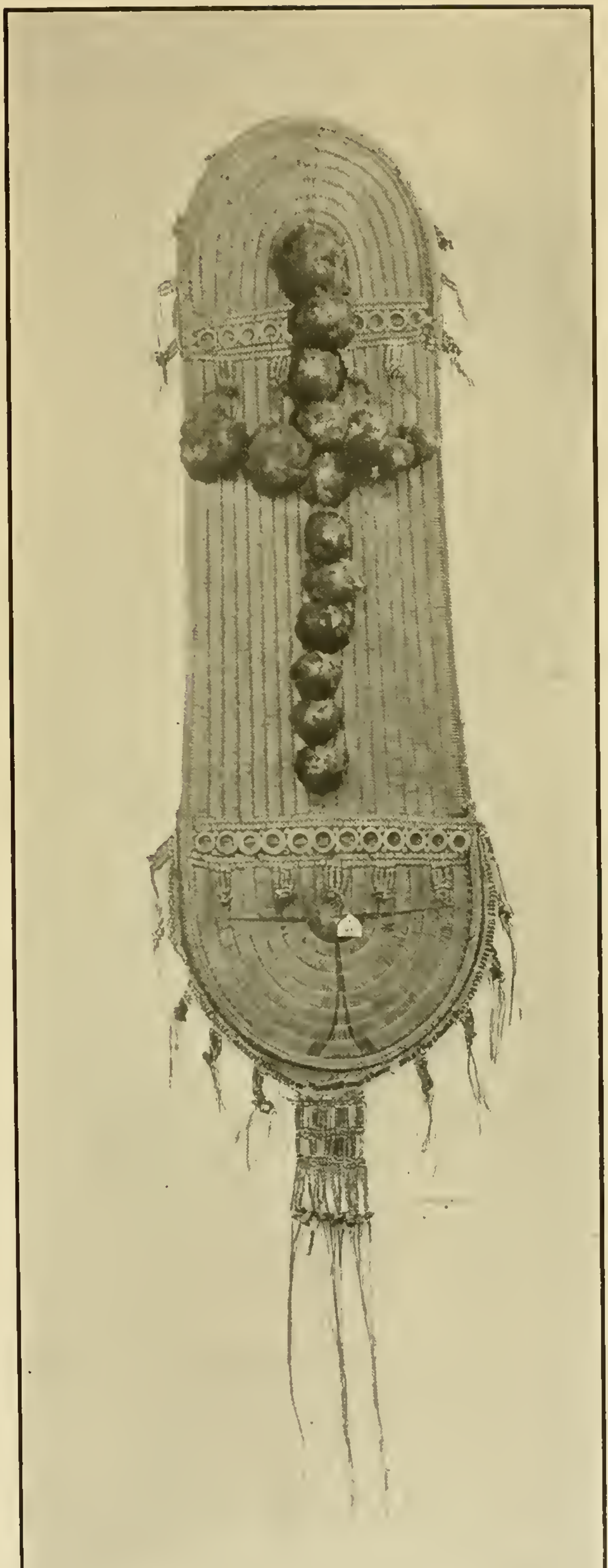


FIG. 21. SOLOMON ISLANDS SHIELD.

shields of a more common sort serve well to explain the material and structure of the shield just described. The shape of the shield No. 1860 differs considerably from that of the one first described, and the weaving becomes a very secondary part of its composition. The shield consists, as may be seen in Fig. 22, of seventeen strips of rattan graduated in diameter from the central one, which is the largest. Besides these rattan strips, which gave the clue to the material of the first shield, where the skeleton is completely concealed by the weaving, are rounded strips of dark colored palm wood which bind the whole together with the help of thirty-two transverse braids. The length is 33 in., and the greatest width is 9.2 in. This specimen is from Ysabel.

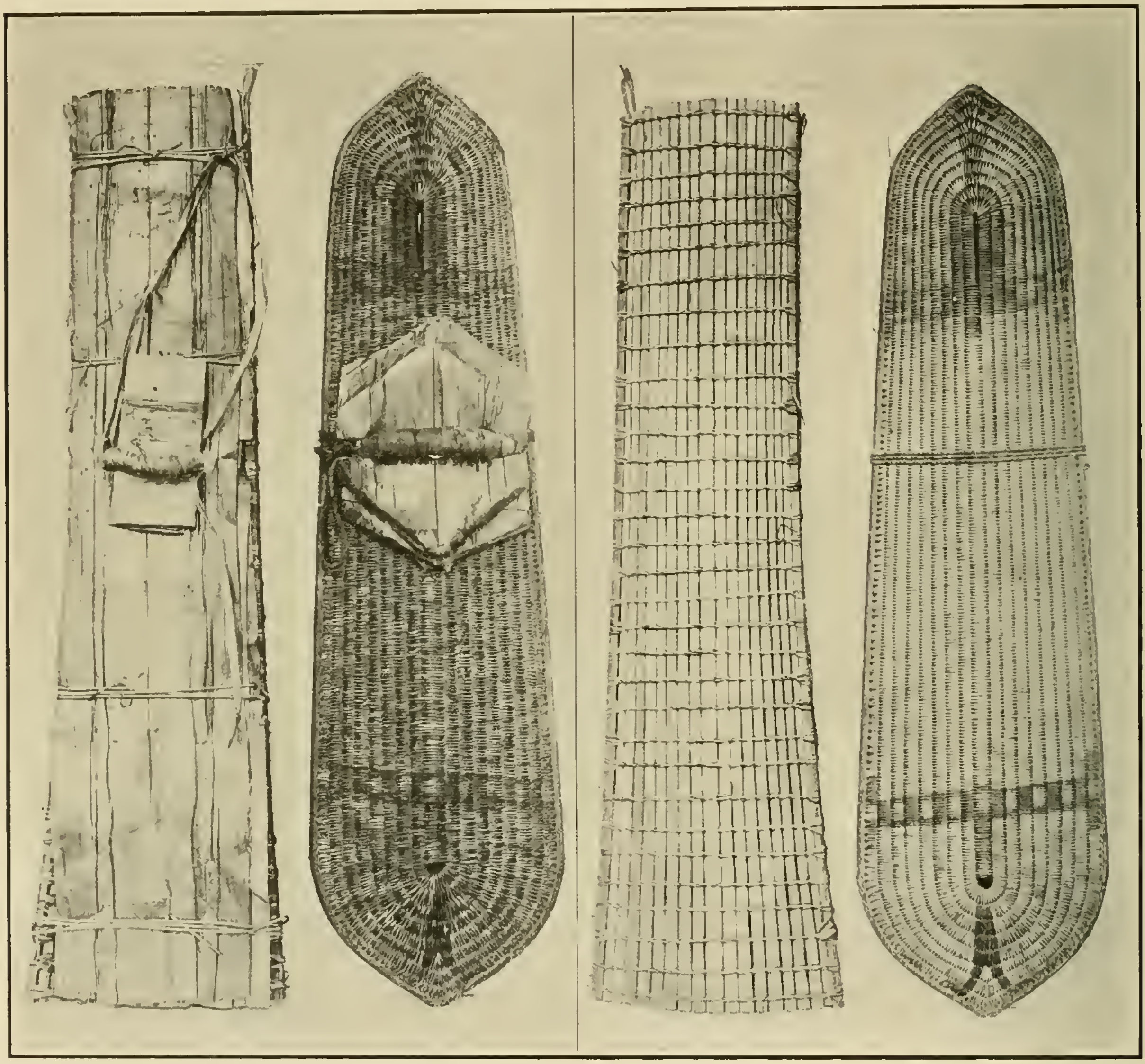


FIG. 22. RATTAN SHIELDS FROM THE SOLOMON ISLANDS.

No. 8315 has more the general shape of the first shield and is made in the same way, but the weave is single and not very close, so that the rattan strips which compose the substance of the fabric are easily seen between the strips of rattan skin. The course of the rattan (for so far as it appears it is a single strip) is spiral beginning at the centre of the lower and larger semicircle and ending on the right-hand outer edge of the smaller end. The designs are woven in with darker strips and are the same on both sides, but the dark and weather-stained surface of the shield renders these indistinct in the illustration. The inside is much less carefully woven, and the pandanus leaf lining is reduced to several hexagonal pads about the handle. This shield came from Rubiana, where its native name is *bako*, according to our collector. No. 1861 is a plain wooden shield of the same shape, and with similar designs in black but without weaving. It is lighter than the rattan shields. In some collections are wooden shields from this group decorated with inlaid pearl shell.

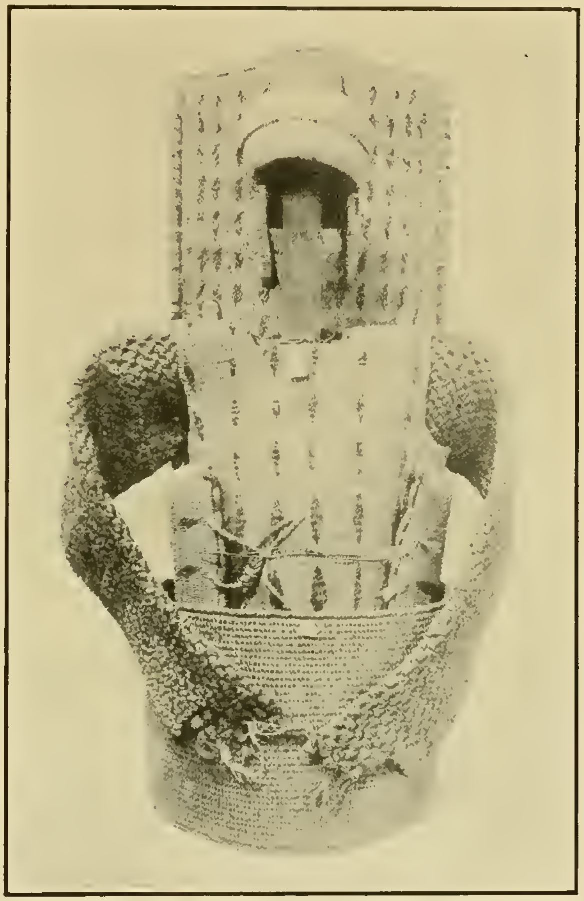


FIG. 23. COCO FIBRE ARMOR. GILBERT IDS.

Besides the leaf the coir or fibre of the external coat of the coconut is much used in basketry. This coir is a well known article of commerce and is common in door mats and carpets, so that no especial description is needed here. In Polynesia its use for sennit is universal. In the olden time the houses were tied together with it; outriggers made fast to the canoes; stone adzes bound to their handles; and in fact it was a most important factor in domestic economy and industrial art.

On the Gilbert Ids. the natives made a most elaborate and effective armor from this fibre that afforded protection from the weapons of shark teeth used in their warfare. Specimens of this armor are in most large ethnological museums, and Fig. 23 will show the common form. There is a jacket and trousers of netted fibre close and tough enough to generally withstand the shark teeth, but certainly so harsh in texture that the hair shirts the penitents of medieval Europe are said to have worn next the skin would be a comfortable exchange. A white man's skin could hardly bear the rasp of the netted fibre. In many cases jacket and trousers are in one piece, like the combination suits of modern clothing, and over all this came the cuirass with its high back to protect the head. While there is no difficulty in tracing the weave, it is hard to see how the stiff and refractory cord was so closely bound together by fingers, however tough and strong. Over this cuirass was often worn a belt of even firmer texture, as shown in the illustration, and the helmet which capped the whole was ample protection from a shark tooth sword, or even from an ordinary club. None of this armor has been made for two generations, and the people of today cannot tell how their grandfathers wove the curious basketry that now is found only in museums. By experiment it is found that a man encased in this armor is unable to get out of it without the help of his esquire, another parallel with the antipodal armor of medieval Europe.

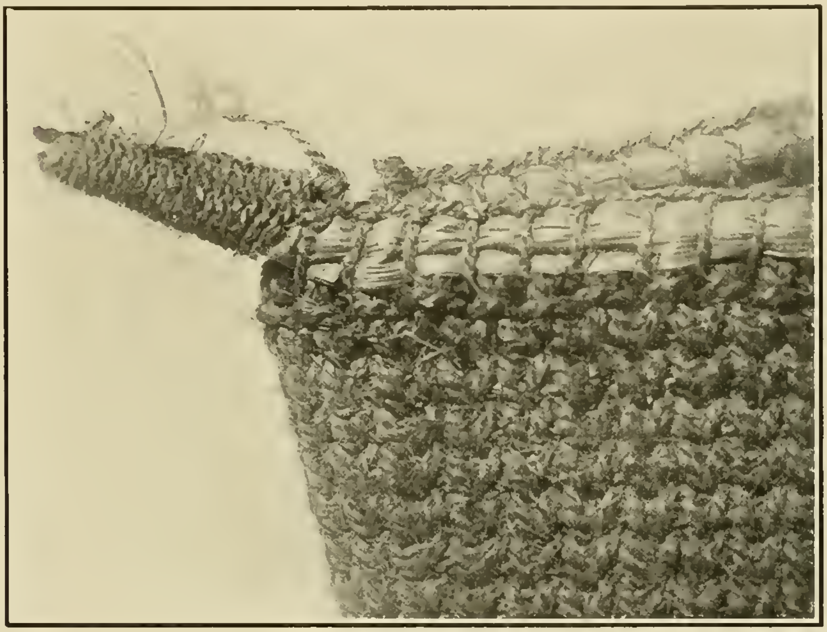


FIG. 24. END OF SENNIT BASKET FROM PONAPE.

Of the basketry proper a good example is shown in No. 7796 of Pl. II—a sennit basket from Ponape. The rectangular bottom is of cord twined over a foundation of sennit and is rather open; but the sides, as may be seen in the illustration (Fig. 24), are closely braided and the top is finished with pandanus leaf bound with sennit. The ends of this border are of split midrib and project 1.2 in., and those of both sides being bound firmly together serve as a spring to keep the mouth of the basket closed. The handles are small loops of sennit about large enough for a single finger. This is, or was, a common Ponapean form and seems very durable. Two specimens in the Bishop Museum are of the same size and pattern, 18 in. long at the top and 10 in. high.

Reference has been made in a previous publication (Director's Report, 1899, p. 25) to the curious way in which sennit is sometimes wound for use or preservation, and the illustration given there may be here repeated for the convenience of the reader (Fig. 25). This braided cord of various sizes was made generally by the old men, who took their "braiding" to the public palavers, much as the old ladies of the higher races take their knitting to an afternoon gathering for gossip or sociability. Before the advent of nails to the Pacific sennit was in universal use, and its wide usefulness can hardly be appreciated by people who have a whole arsenal of nails, screws, bolts, clamps, etc. But our interest here is in the use made of this braid in basketry. Besides the example from the Carolines we have the curious cylindrical covered basket from Tonga, of which I have seen one in the Berne Museum and two in the British Museum (Fig. 26), but I believe them to be very scarce in the Tongan group at present. They are plaited in brown and black triangles, and decorated with white, seldom black, shell disks. Mariner gives in his account of the Tongan Islanders (1817) the following description of Tongan mats and baskets:

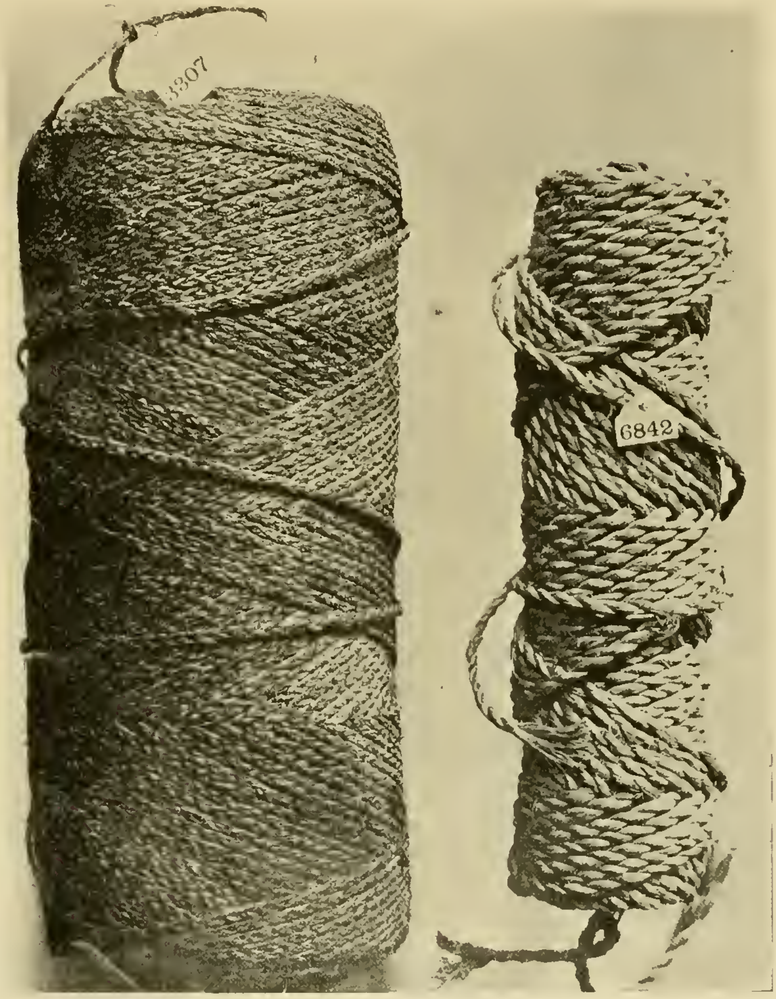


FIG. 25. ROLLS OF SENNIT.

> In respect to mat and basket making, they have mats of various kinds, made of strips of leaves or bark selected, dried, and otherwise prepared; all of which, except one or two of a coarser kind, are fabricated by women. The following are the names and quality of them:
>
> GNAFI GNAFI [GAFIGAFI].—Mats to wear, of a finer quality, made of the leaves of the *fa* or *paoongo* [pandanus], that have been transplanted, in order to give them a finer and softer texture.
>
> GIE.—Stronger mats made of the bark of the *fow* [fau=hibiscus], or *olonga* [olonà], worn chiefly by people in canoes to keep out the wet, as the water does not damage them: they appear as if they were made of horsehair........
>
> FALLA.—Mats to sleep on, made of the leaves of the *paoongo*. These are double, and are of various sizes, from six feet by three, to seventy or eighty feet by six; to lie along the whole length of the house.
>
> LA.—Mats for sails, made of the leaves of the *fa* [pandanus]; they are very strong and light.

TACAPOW [TAKAPAU].—Mats for flooring houses, made of the young leaves of the cocoa-nut tree.

TATTOW [TATAU].—A sort of matting, plaited in a very ornamental way, made of young cocoanut leaves: they are used to screen the sides of the houses from the weather.

CATO [KATO].—Baskets: these are of various constructions; sometimes of a sort of matting made with the leaves of the fa, paoongo, lo acow [akau=sugar cane], etc.; at other times of the fibrous root of the cocoanut tree interwoven with plait made of the husk of the nut, and have rather the appearance of wicker-work: the latter are sometimes variously stained and ornamented with beads or shells worked in. The larger and coarser baskets are generally made by men, to hold axes and other tools in; also the baskets to hold victuals, made of the leaves of the cocoanut tree are generally made by men.

BAWLA.—Mats for thatching houses, are either made by men or women, but more frequently by the former.—Vol. II, p. 293.

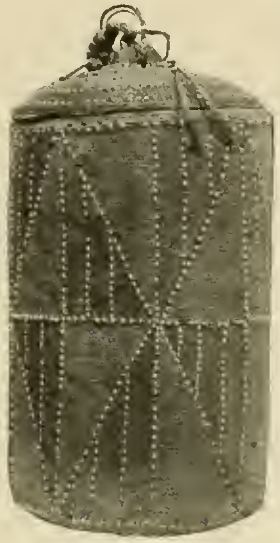


FIG. 26. TONGAN BASKET IN BRITISH MUSEUM.

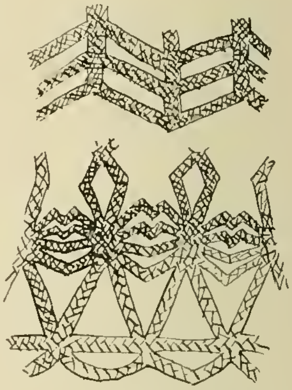


FIG. 27. OPEN WORK MATS FROM TONGA.

The Tongans also covered wooden boxes with basket work, as we shall see later that the Hawaiians did with great skill. The Tongans had oblong baskets in black plaiting with brown decorations; a square basket of unusual weaving, as shown in the Museum at Berne, where many of the specimens date from the time of Cook, whose artist, Wäber, was a native of that city and bequeathed all his collections to that municipality. With these were specimens of the curious open-work mats (of pandanus) shown in Fig. 27. In New Caledonia the gourd calabashes were artistically corded with sennit. The use of sennit on Fijian clubs, both for the grasp and for decoration, may also be noted. Even the Fijian spears were often ornamented with bands of fine black and white sennit. Not only the braided form was used, but also the plain twisted cord.

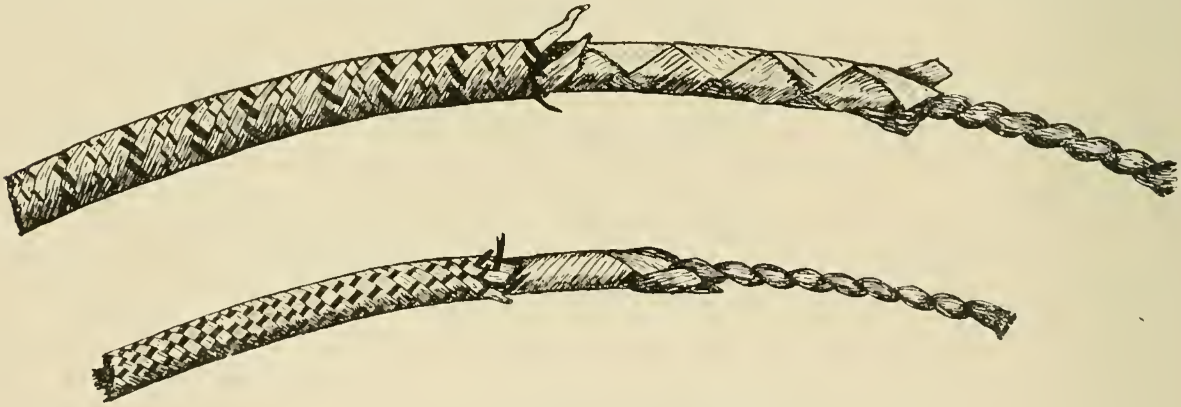


FIG. 28. COCO CORDS FROM MICRONESIA.

In the Carolines the braided slings of this fibre were sufficiently ornamental to serve as headbands when not in use for throwing stones. In the Marquesas a broad, flat braid was used for holding taut the heads on the large wooden drums. On Hawaii a smaller braid was used for the same purpose; and also, as will be seen later on, for securing the covers to the fine baskets of *ieie*.

The Fijian temple house was sometimes entirely covered with sennit, and small models of these are in many museums, constructed of the same durable material. The attachment of the stone axe or adze to its handle was by coconut cord neatly interwound. By the same means the parts of a canoe were united, and the cable for the stone anchor was generally of the same material, as it did not rot when wet.

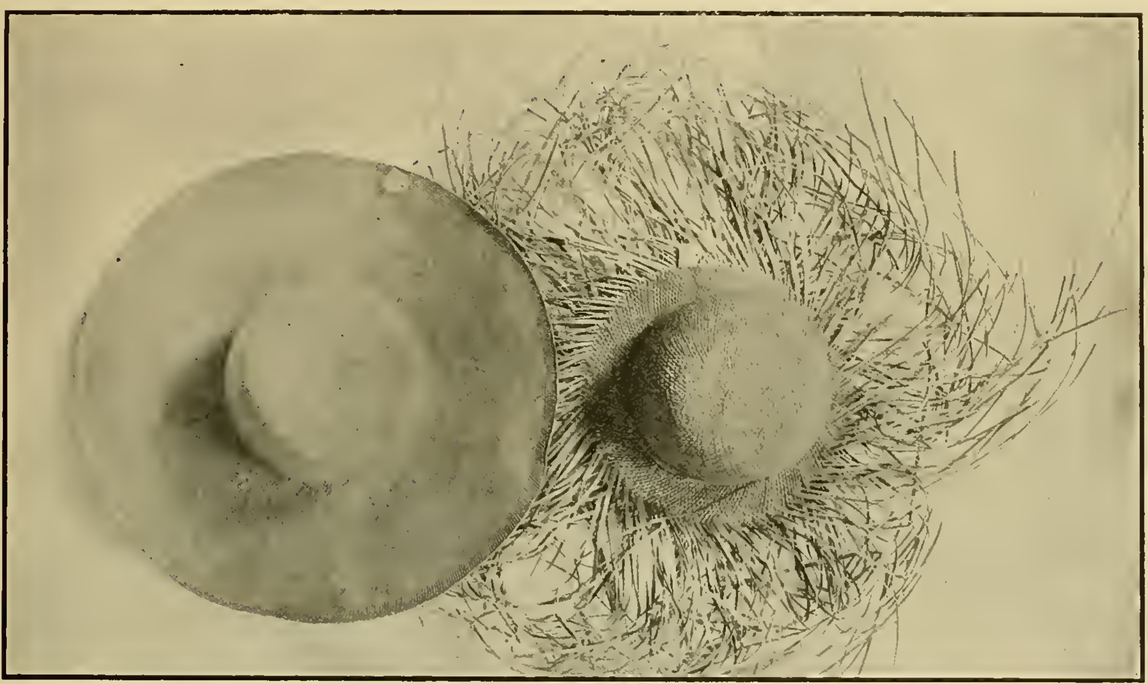


FIG. 29. PALM LEAF HATS FROM GUAM, MARIANAS.

Decorated Cord.—A coco fibre cord used in coils for belts, and for other purposes of ornamentation, is covered with a neat braid of pandanus leaf, and dyed hibiscus bast mingled in many tasty patterns. These cords were, in former years, brought to Honolulu from the Marshall and Gilbert Islands, and were much used for hanging pictures, as the strong fibre was not eaten by insects. This beautiful cord is formed in three concentric parts, as shown in Fig. 28. First a cord, usually of two-ply coco fibre; then comes a coat of plain pandanus; third, the woven coat of brown and black, which gives the cord its beauty and variety. The weavers must have very deft fingers, but I do not know whether the two pandanus coats are put on separately or simultaneously, that is, in close succession. There are many sizes and patterns of the cord in this Museum.

The rootlets of the coco palm are small and of nearly uniform size, well adapted for basket work. A fish trap that I once purchased at Pagopago was made of these white rootlets and measured 20 in. in diameter and 10 in. in depth. As I carried it from the canoe up the accommodation ladder of the steamer, the Samoans, assembled in their canoes about the ship, set up a shout, imagining the foreigner was going a fishing.

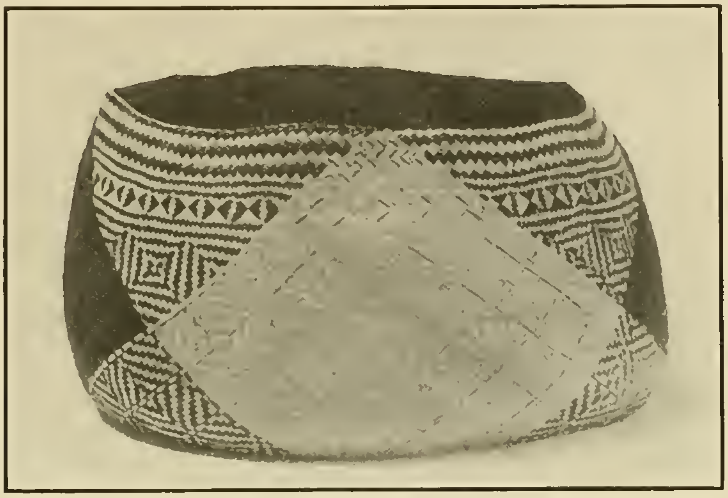


FIG. 30. BASKET OF PALM LEAF, SOLOMON IDS.

The native palm, of which there are two species on the Hawaiian group—*Pritchardia gaudichaudi* and *P. martii*—is much used for hats, baskets, mats and fans. The leaf is palmate and sometimes 4 ft. in diameter; the young leaves are used before they have become green, and usually are split into strips not exceeding ⅛ in. in width, and for hats these are much narrower. Young leaves of the date palm are used in the same way, but they have less flexibility than the loulu or native palm, and so are not as well adapted for hats. As in ancient times the Hawaiians wore no hats, this industry is modern, and so far as hats are concerned it extends without much variation through Micronesia. Fig. 29 shows two hats of palm leaf, one of fine texture finished, the other coarser, partly braided. Natives of Hawaii making similar, though not so fine, hats of loulu palm are shown in the figure on the title page, a view taken in 1888 at Napoopoo, Hawaii, by Mr. Acland Wansey, formerly of the Museum staff.

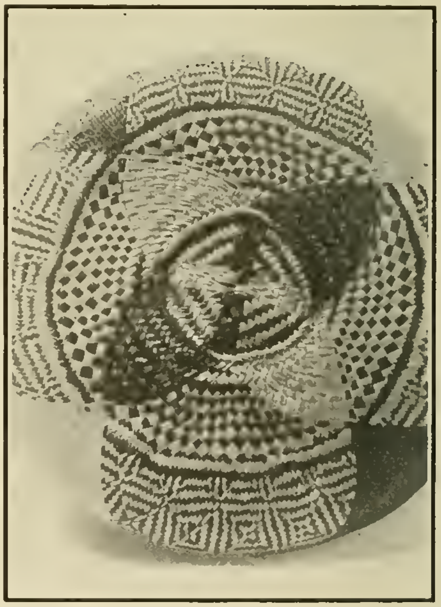


FIG. 31. BOTTOM OF NO. 8312.

For a very interesting basket of palm leaf we must turn to the western Pacific. On the Solomon Islands is made a basket of bowl shape, flexible, so that when empty it can be folded together like a good Panama hat. It is tastefully decorated with red and yellow strips, as can be seen in Fig. 30. The curious matter in its construction is that it has neither beginning nor end; it is a ring. Where the navel or point of beginning of an ordinary basket is found here is a hole 3.5 in. in diameter, the edge finished off as if the basket was complete at that place, as can be seen in Fig. 31, which represents the bottom of this basket, No. 8312. To complete the basket the maker sews in a square patch, which seems like putting a square peg in a round hole, but as the square patch is sufficiently large to cover the round hole the basket is complete. The patch is solidly interwoven, but as may be seen in Fig. 32, which presents the inside of the bottom, it is not a very trim contrivance. What the object of this feature is I do not know, but conjecture that the maker finds it more convenient to pass her hand through the hole while weaving. In two similar baskets in this Museum, although only half the size of the one illustrated, the bottom is pierced with a hole of the same size. The collector of these baskets did not notice the peculiarity, and so did not inquire the reason, and letters sent to the island Florida where they were made have not yet brought a reply. That the construction is not peculiar to this particular form of basket is seen in another made of coco leaves shown in Fig. 34. This bowl-like basket is 13 in. in diameter and 6 in. high. The mat plug is ornamentally woven to match with the basket, and the ends of the strips are knotted in the rim and left long, which would seem to be an objection to the pattern.

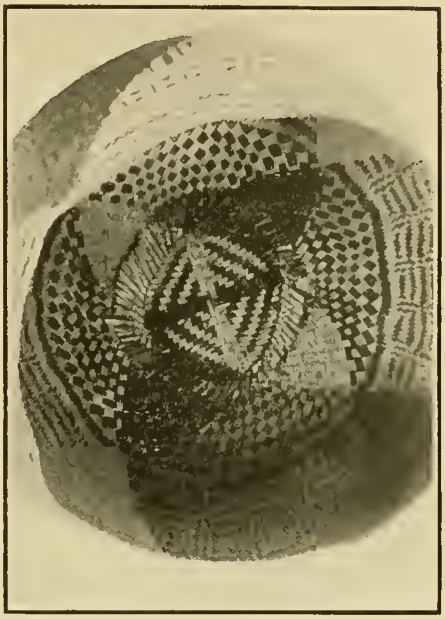


FIG. 32. INSIDE OF NO. 8312.

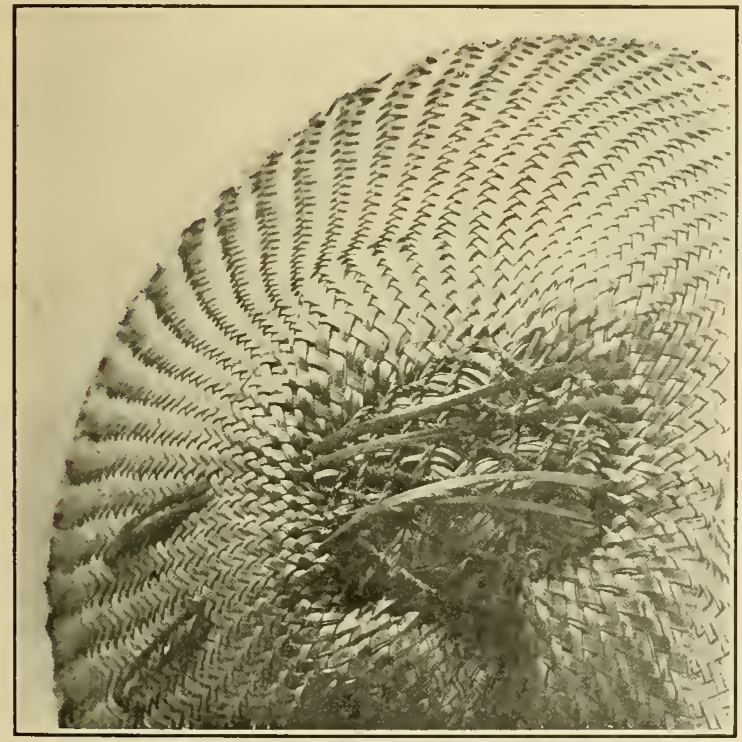


FIG. 33. BASKET FROM NEW HEBRIDES.

In the New Hebrides we find a similar structure, shown in Fig. 33, where the central portion of a coconut basket is filled with a rude "darn" of coco cord. The long strips crossing the bottom appear again on the sides and serve for handles to this very flexible basket. Returning to basket No. 1888 (see Fig. 34) we also come back to our primitive coco leaf structure. The midrib is split and cut into short sections with the leaflets attached, and these sections break joints all round the inside of the rim, as shown in the figure, where one is supposed to be looking into the basket. The weave is usually a three-leaf twill changing four times in the circumference from the vertical to horizontal with five-leaf twill; the upper rim is braided. To make the basket of good substance the leaflets are double, the midrib in centre of fold, so that it shows on the external edge of the strip. The basket is 14 in. in diameter and 9 in. high, and the bottom hole is 4.5 in. in diameter, and the plug, as may be seen in the figure, is rudely rounded, the ends of the doubled leaves being left very long. There are no handles. The basket in the upper part of the illustration is also from the Solomon Ids., but of a very different model and material. It is certainly a common form of food basket, as the Museum possesses three examples, two of them quite large. In these the bottom is made in the usual way without the mysterious hole. In our ignorance of the botany of the Solomons it is difficult to determine the material used, which much resembles rattan and was so labelled some years ago. If it be calamus it has been dyed a dark brown, almost black. Cane baskets of coiled work are common among the Australian natives; another in this collection is from Fiji; and still another from New Britain. A plain flat rattan basket from Santa Cruz is shown in Fig. 35. This is 20 in. in diameter, and the splints of rattan are taken in threes and simply interwoven; the ends are not turned but bound into a rim of sticks, an insecure method, as may be seen at the bottom of the figure. The absence of the genus *Calamus* in most of the Polynesian groups is sometimes made up by the use of bambu, but usually the flexibility of the former cannot be imitated by the stiffer grass. In the Pelew Ids., however, baskets of bambu have something of the

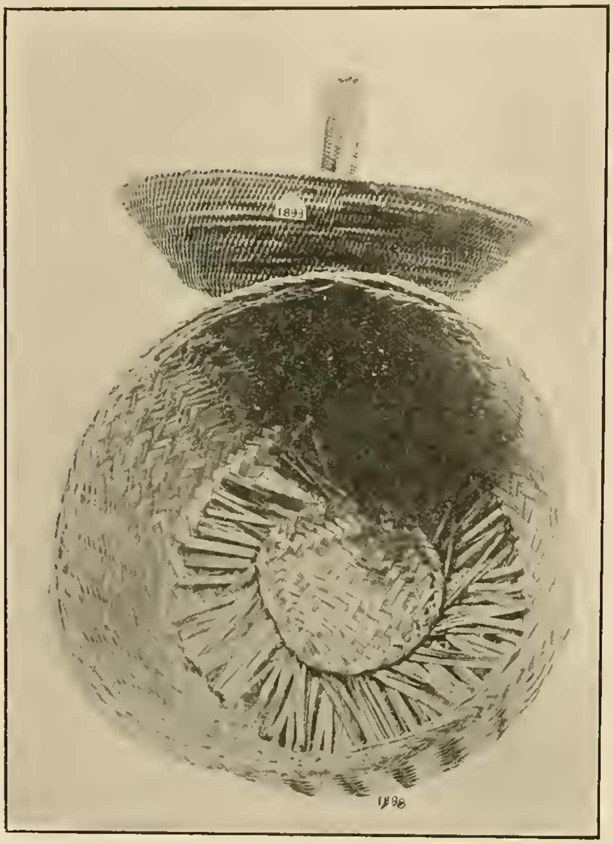


FIG. 34. BASKETS FROM FLORIDA, S. I.

rattan physiognomy (Fig. 36). In the specimens figured, Nos. 8073-4, three stout strips serve for frame; over these the body is uniformly woven and the ends turned on sticks wound over and over by thin strips of bambu to form a rim. The bilge of the basket is protected and kept in shape by a twining of two bambu ribbons. These baskets are 8 in. in diameter and 3 in. deep. They approach the Chinese work closely.

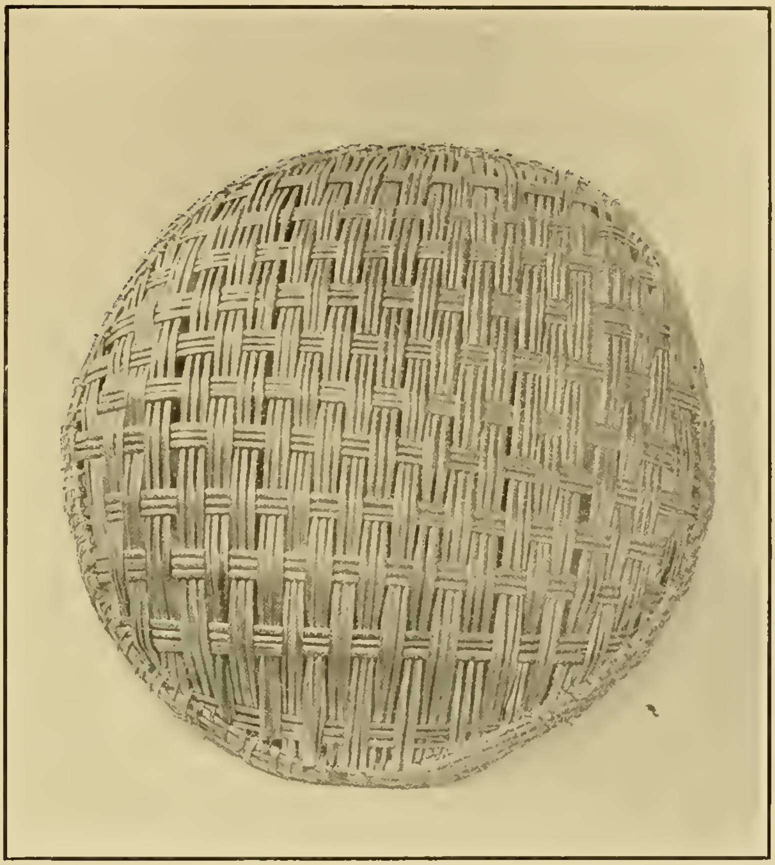


FIG. 35. BASKET FROM SANTA CRUZ.

Other satchel-shaped baskets of palm are in the Museum collections, but the localities are uncertain, and it seems better to pass them by, for the present at least. In the East Indies rattan is used to make excellent sleeping mats, and I have seen palm leaf used for the same purpose, and as carefully finished as the strips of palm used for books. I know of nothing of importance in the nature of mats made from palm in Hawaii or the rest of Polynesia, except those of the loulu palm of the Hawaiian group. These are smooth, rather stiff, and are used for beds or for tables. One in the author's possession measures 5×7 ft., and has thirteen strips to the inch. Another in the Museum, No. 2790, measures 6.5×5 ft., and has the same fineness. They are less durable than the pandanus mats.

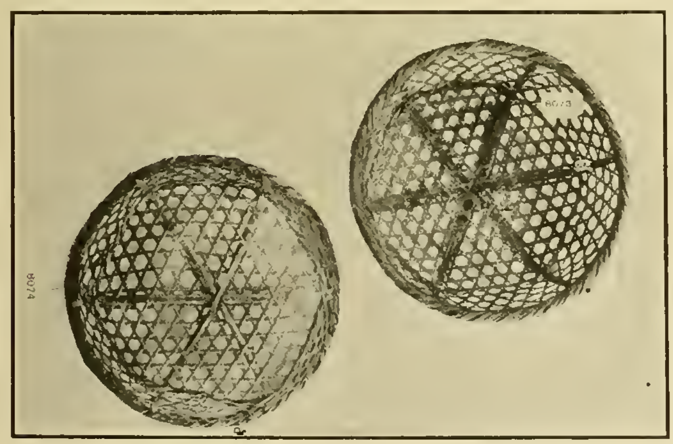


FIG. 36. BASKETS FROM THE PELEW IDS.

Pandanus Work.—Useful as the Cocos, King of Palms, undoubtedly is, the pandanus is more used in the Pacific region. For mats it ranks first; and for satchels, sacks, or any construction where flexibility must be conjoined to toughness and durability it generally displaces the stiff leaf of the coco or the harsh and less pliable coir.

Of the genus *Pandanus* there have been described half a hundred species, chiefly found in a region of the Tropics extending from the islands off the East coast of Africa to the eastern limits of Polynesia: a single species has been described from the West Indies. There is, however, great uncertainty in the differentiation of these species, owing partly to the difficulty of preserving for herbaria the male flowers and large female fruit resembling a large pine cone, from which the common name "screw pine", but unlike the pine the pandanus cone falls to pieces when ripe or dried, the keys clinging but loosely to the core. Although the trees of the Hawaiian Islands have all been referred to *P. odoratissimus*, there are marked varieties in the fruit (as the fine red *hua hala*, much prized for lei among the Hawaiians) and the texture and size of the leaves differ greatly, although this may be due to location and soil. In the Micronesian region the fruit is edible and forms an important article of food, while in the Hawaiian group it is not very palatable. Leaves in this Museum from the southern islands are finer and narrower than the Hawaiian, while rolls from Guam cannot be

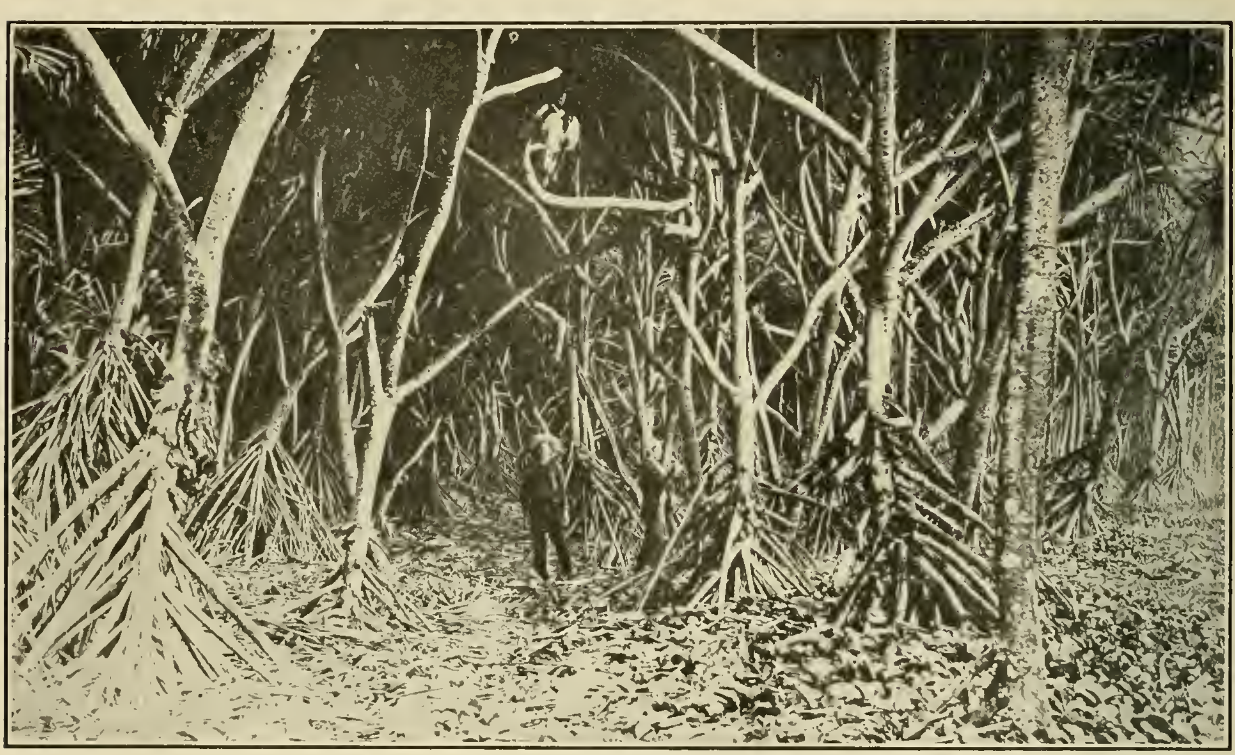


FIG. 37. PANDANUS GROVE IN PUNA, HAWAII (1888).

distinguished from the native product. Much of the uncertainty at present with the genus pandanus will soon be removed, by the labors of European botanists who are revising the species, but in the meantime fortunately our study of the use of the leaves in basketry does not depend in the least upon the name assigned to the particular trees that furnish us with the leaves used in these islands.

Forty years ago there were many groves of pandanus or *hala* as the native name goes, besides scattered specimens, so there was no need of cultivating the tree like the breadfruit and coconut about the houses, but the increased cultivation of sugarcane has caused the destruction of the native trees, and groves like the one shown in Fig. 37 are now uncommon. The scarcity of leaves and the disinclination of the natives to use those still attainable has made lauhala mats and baskets scarcer than the mats and baskets imported from China, and the native manufacture is journeying towards extinction like so many other industries of the olden time. Puna was a famous region for hala mats, and in 1864 the author, when journeying through the district with that noble missionary the Reverend Titus Coan, saw many a party in the curious open caves (caused by a breakdown of the lava crust in some of the many streams of lava, ancient and recent, that form much of the surface of Puna) busily engaged in weaving mats, a work for which the comparative coolness and dampness of the caves was most suited. A quarter of a century later in traveling the same road with a younger companion the scene was greatly changed: the caves were there, the hala trees were there, but the inhabitants had gone, and for sixty miles there was nothing but a few deserted churches and some aged breadfruit trees to tell that once people had lived there. Fifteen years later the scene had again changed owing to the opening of roads and the cultivation of sugarcane, but the present inhabitants were not the old natives, and the mat making is only here and there continued when there is a chance to sell to the foreigner.

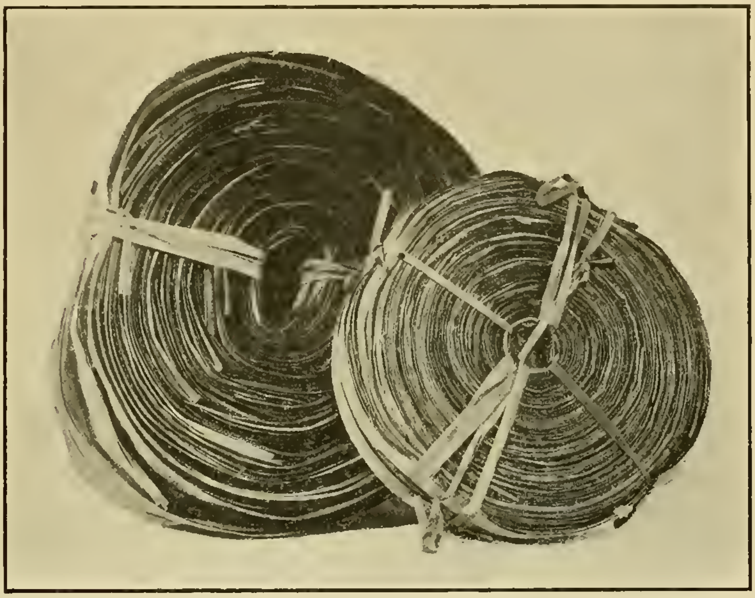


FIG. 38. ROLLS OF HALA LEAVES.

In size the hala leaves differ greatly and some exceed 6.5 ft. with a width of 7 in. In the groves like the one figured (Fig. 37) the ground is thickly covered with the deciduous leaves. The base of the leaf which broadly clasps the stem, is cut off and the very prickly margin also removed. This was especially the work of the old women, and as late as 1888 I saw an ancient dame near Kailua, on the western side of Hawaii, continuing the work of her ancestors. She was reputed to have outlived the century mark, cramped in every joint, unable to stand erect, kenneled in a grass hut not four feet high, she was still busily and cheerfully trimming hala leaves with a sharp shell. As I watched her slowly completing her task there came back to my memory most vividly the groups of old women I had seen in Puna doing the same thing while the children gathered up the refuse or laid aside the neat rolls (Fig. 38) into which the prepared leaves were rolled to keep them flat. Drying the leaves was done in the sun or in the shade to secure the differing tints of brown so ornamental in combination in the more elaborate mats. The leaves are readily split longitudinally, and in mat making strips from ⅛ in. to 1.5 in. are used. If the full width of the leaf is needed the midrib must be trimmed down, otherwise the blades on either side are alone used.

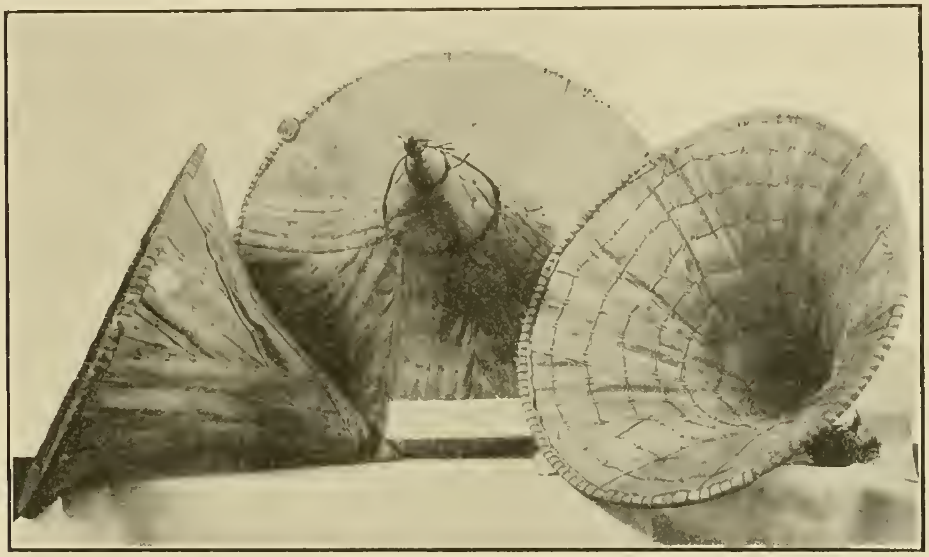


FIG. 39. PANDANUS HATS FROM THE CAROLINES.

Pandanus Hats.—While the natives of the Pacific were not a hat-wearing race, on certain occasions some shade or protection was required in spite of the usually thick crop of hair. Such are the long exposures to the tropical sun above and to the gleam from the water beneath in reef-fishing, and from Guam through Micronesia the pandanus leaf is made into a single pattern of conical hat for the fisher's use. Fig. 39 will show the simple structure. The leaves in several layers are stitched together with two-ply coco cord and are bound solidly and neatly at the apex and around the rim. The hats illustrated are from Ruk in the Carolines, but specimens in the Museum from

Guam are precisely alike. They are all nearly of one size (19–21 in. in diameter), and are tied under the chin. The simple vizors of the Fijian and the Solomon Islander answer the same purpose.

From Ebon, Marshall Ids., comes a pandanus mat of neat and curious construction. The leaves are selected of full width, excepting, of course, the prickly edges, and are strung double on strips of the same material, 3/8 in. wide. These strips show full length on the inside (see Fig. 40), but on the outside there are four stitches shown, and these come at the edges of the leaves in such a position as to bind them securely together. Between the rows of stitches, and of course between the double leaves, are inserted free single leaves to give body and elasticity to the mat, which in the specimen illustrated is 25×45 in. Two of these mats are sewn together by a stout seam of pandanus strip, shown on the bottom of the figure, while the other edge is neatly hemmed, as may be more clearly seen in Fig. 41. The long binding strips are simply

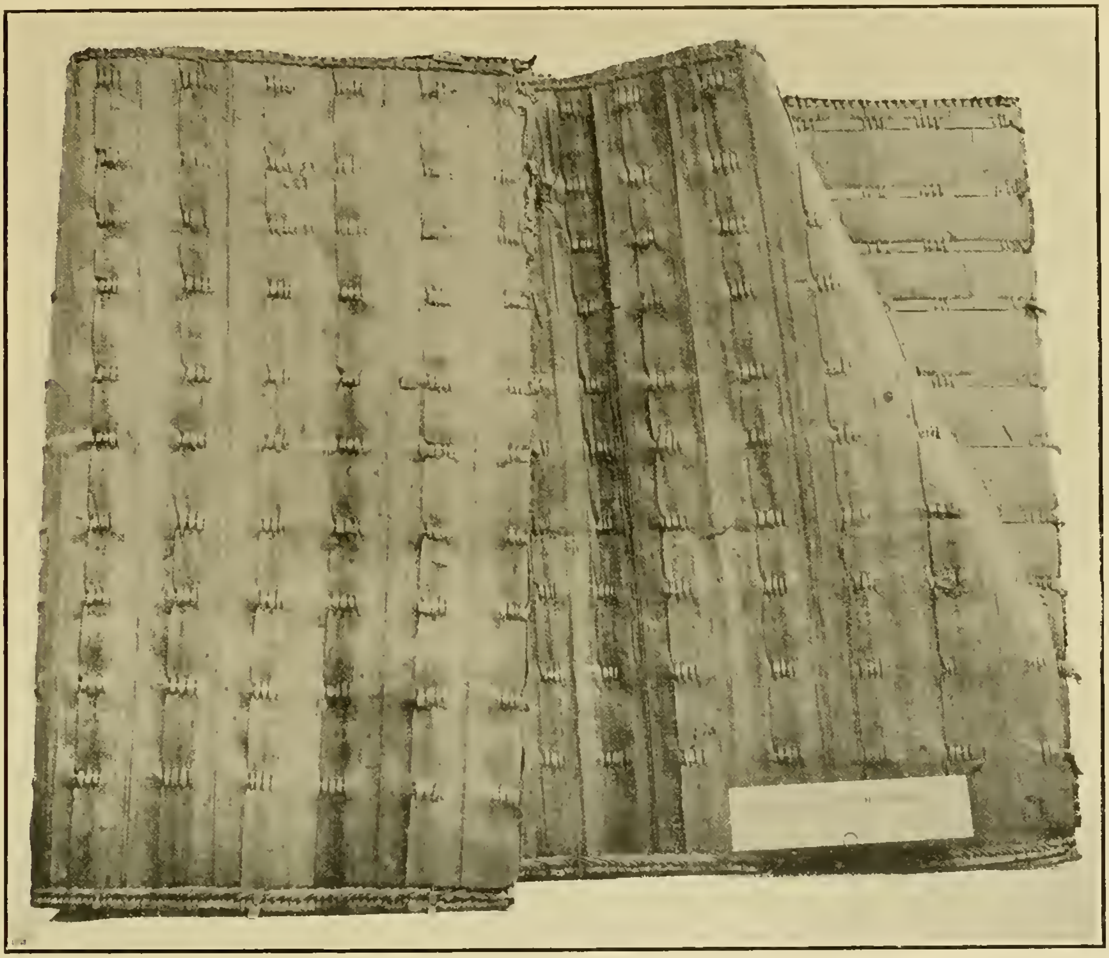


FIG. 40. PANDANUS MAT FROM EBON.

knotted at the end of the mat. This certainly makes a smooth, elastic and very comfortable mat. Those who live in cold climates can hardly appreciate the great comfort in sleeping on a hard surface covered only with a leaf mat. Feather beds, matresses, spring beds are quite superfluous to one accustomed to roll up his bed when he awakes in the morning.

Another sleeping mat or *sarung* from Shortland Id. of the Solomon group is 6 ft. 5 in. long, and 3 ft. 2 in. wide, made of the same wide pandanus leaves joined at the edges by almost invisible coco cord stitches, and like the preceding in double series so that the outer and inner leaves break joints. The ends of the leaves are not turned but sewed together by a running seam of coco cord, one cord extending along one side while another is put through the leaf from the other side and over the first cord. The leaves are of great width (6–8 in.) and are sewed together and then turned, a single thread extending the length of the leaf and then knotted and a few loose inches allowed to hang as a fringe. This forms a bed both smooth and waterproof.

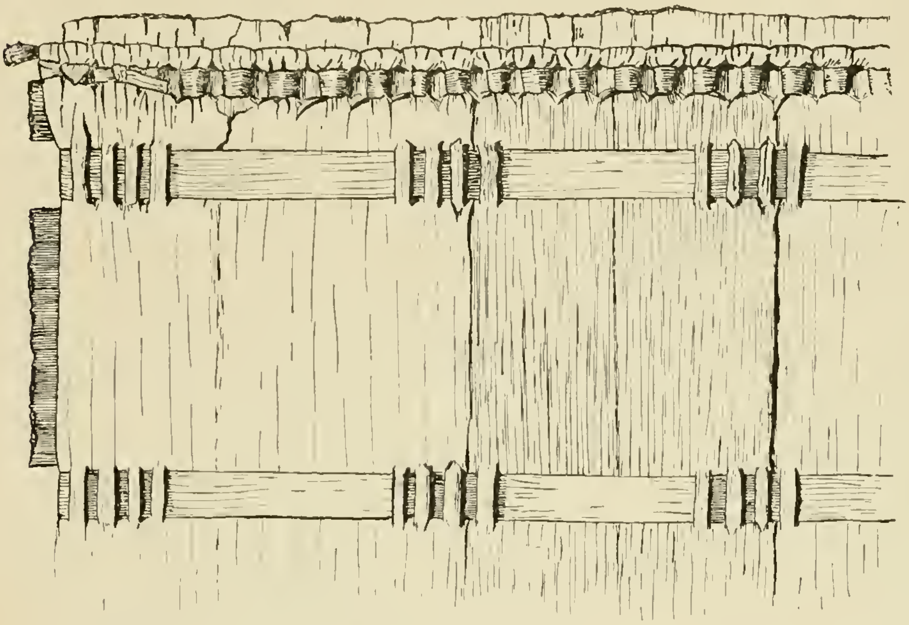


FIG. 41. EDGE OF EBON MAT.

The most elaborate of these unwoven pandanus mats known to me are those from the Caroline Ids. which in former times were frequently brought to these islands by the mission vessels from Micronesia. The leaves, as may be seen in Fig 42, or more distinctly in the diagrammatic Fig. 43, are arranged like clapboards transversely to the length of the mat, and are attached to each other as in the preceding example. The leaves, instead of being very broad, are in very narrow strips not over half an inch wide and are placed so closely that only about one-eighth of each leaf shows. As in the first example from Ebon longitudinal leaves serve both to give body to the mat and to bind the whole together. One can see that it would be difficult to roll up such a mat with the ends of these imbricated leaves bound to a stiff rim, and the maker has ingeniously surmounted the difficulty by trimming the ends of the leaves underneath for about one-third of an inch, the remaining portion being bound with pandanus leaf in several layers sewed on over and over with coco cord. The individual leaves are bound together by untwisted hibiscus fibre, and the whole structure is well adapted for rolling up. In use the unrolled portion is the bed, that remaining rolled up is the pillow, of which the shortest persons have the greater share. These mats are made in different sizes, as may be seen by the measurements of the few in this Museum:

Sleeping Mat or Lock No. 7835, 49×120 in.; from Ponape.
Sleeping Mat or Lock No. 3493, 16.2×120.7 in.; from Ponape.
Sleeping Mat or Lock No. 3492, 18×32 in.; fragment.

Among the fabrics of sewed pandanus are the fine kites of the Gilbert group. Like the Ebon mats already described and figured are the mat coverings for sails when furled, common where mat sails are used, as these sails are too heavy to be easily removed but are more conveniently covered while in the canoe. Models of these are in the Bishop Museum collection of canoe models.

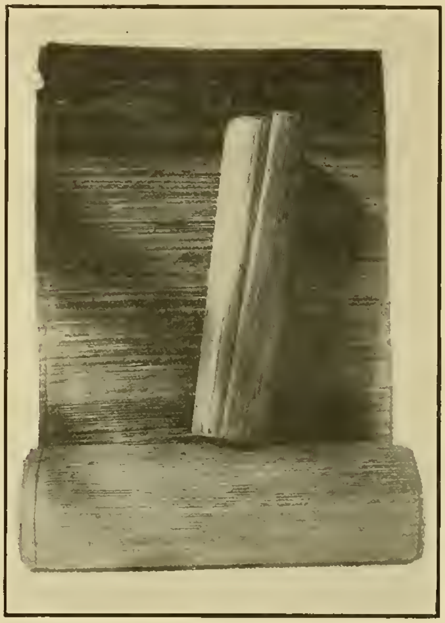


FIG. 42. MAT BEDS FROM CAROLINE IDS.

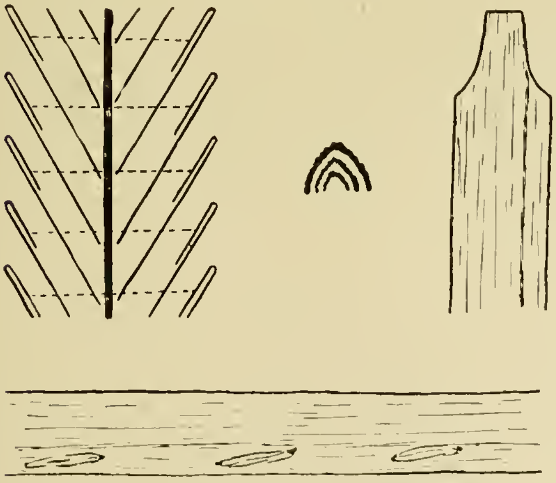


FIG. 43. STRUCTURE OF CAROLINE MAT.

Pillows=Uluna.—A simple work of the pandanus weaver were the very comfortable pillows made in the form of a parallelopipedon and stuffed usually with the harder parts of the same hala leaves. Strips ⅜ in. wide were usually used in the common forms, but in No. 1144, shown in Fig. 44, a much wider strip is used (⅞ in.) and ornamentation is added by the insertion of darker leaves in the finished pillow. In No. 1147, a specimen from Queen Emma's collection, double strips 1.2 in. wide are used. In Nos. 7732-33 the ends of the latter are of the usual ⅜ in. strip and plain, while the rest of the pillow is covered with narrow (⅛ in.) dark strips twilled to form ornamental zigzags or checkers. This covers the whole of No. 7732. After the pillow was woven it was embroidered with the dark strips by splitting the alternate longitudinal strips into three. In size these pillows vary considerably, as may be seen in the following table:

NO.	SIZE.
1144	10×6×4
1145	20×5.2×4.5
1146	10.5×6×3.5
1147	10.5×6×4
1148	13×5×4
1149	10.5×4.5×4
1150	19×5×6
1151	10.5×4.5×3.5
1152	8×3×4.5
1153	7.5×3.5×4.2
7732	9.5×4×3.5
7733	8.5×3.7×3.5

A small cubical pillow made in the simple pandanus weave served for a ball in the games of many of the Pacific islanders, and specimens from the Hawaiian, Gilbert and Caroline Islands are in the Bishop Museum. These were too light to be thrown to any considerable distance. Descriptions of the games played with these cubic "balls" must be reserved for the chapter on Ancient Hawaiian Sports.

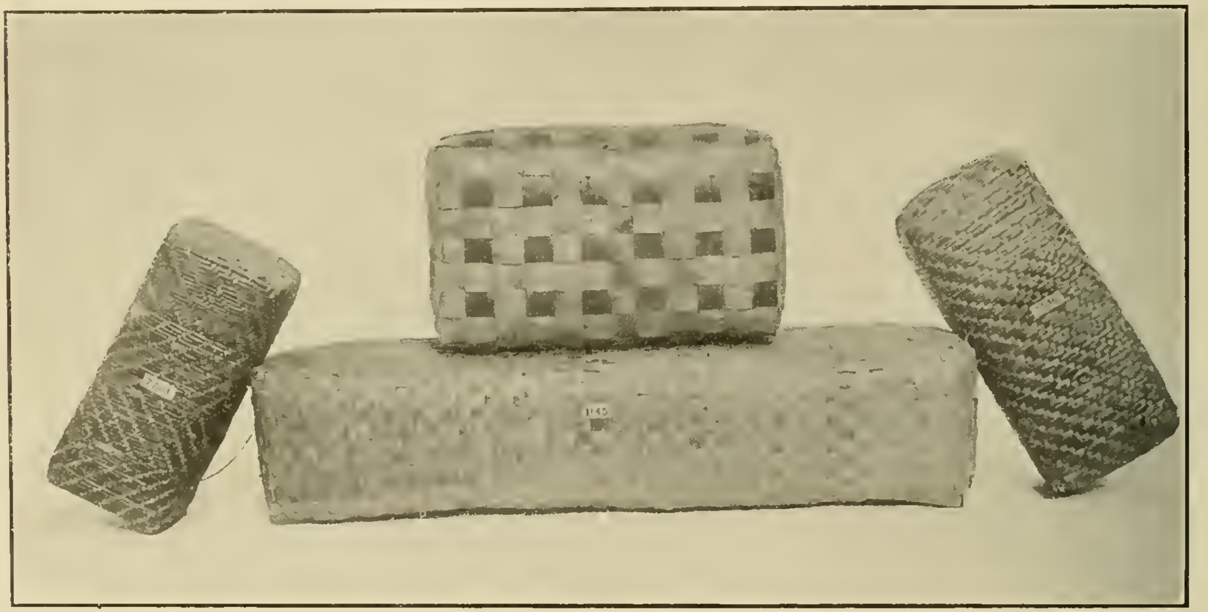


FIG. 44. HAWAIIAN PILLOWS.

Pandanus Baskets.—The method pursued in jumping from mat to basket may seem arbitrary, but, as those who take the pains to read through the present account of Polynesian basketry will see, there is no convenient partition between basket and mat; a basket is a folded up mat, or a mat is a basket opened out, especially in the forms most common in the Pacific. As I have grouped the products around the material rather than around the technical process that has been employed, I shall describe mats or baskets as these seem naturally to be in the line of succession.

Among the Hawaiians hala baskets were very common, and in most cases very ugly, as may be seen in the illustrations (Figs. 45–46). That they were found useful their continued manufacture to the present day testifies, and personal use of them convinces me that they are light and durable. In all cases figured the bottom was a square mat continued vertically to a round aperture without change of diameter in those shown in Fig. 45, the rim being turned and finished in the simplest manner. In the largest, which were used for storage, no handles were provided; in the others cords braided or twisted of coir, oloná or hau fibre crossed the bottom either diagonally or parallel to a side, passing between the weave on the outside once or twice or more, ending in two loops of suitable lengths for handles. In small baskets of this pattern a stiff handle of braid was often sewed to the sides near the rim, as shown in the figure. The dimensions of these baskets, from the specimens in hand, are as follows:

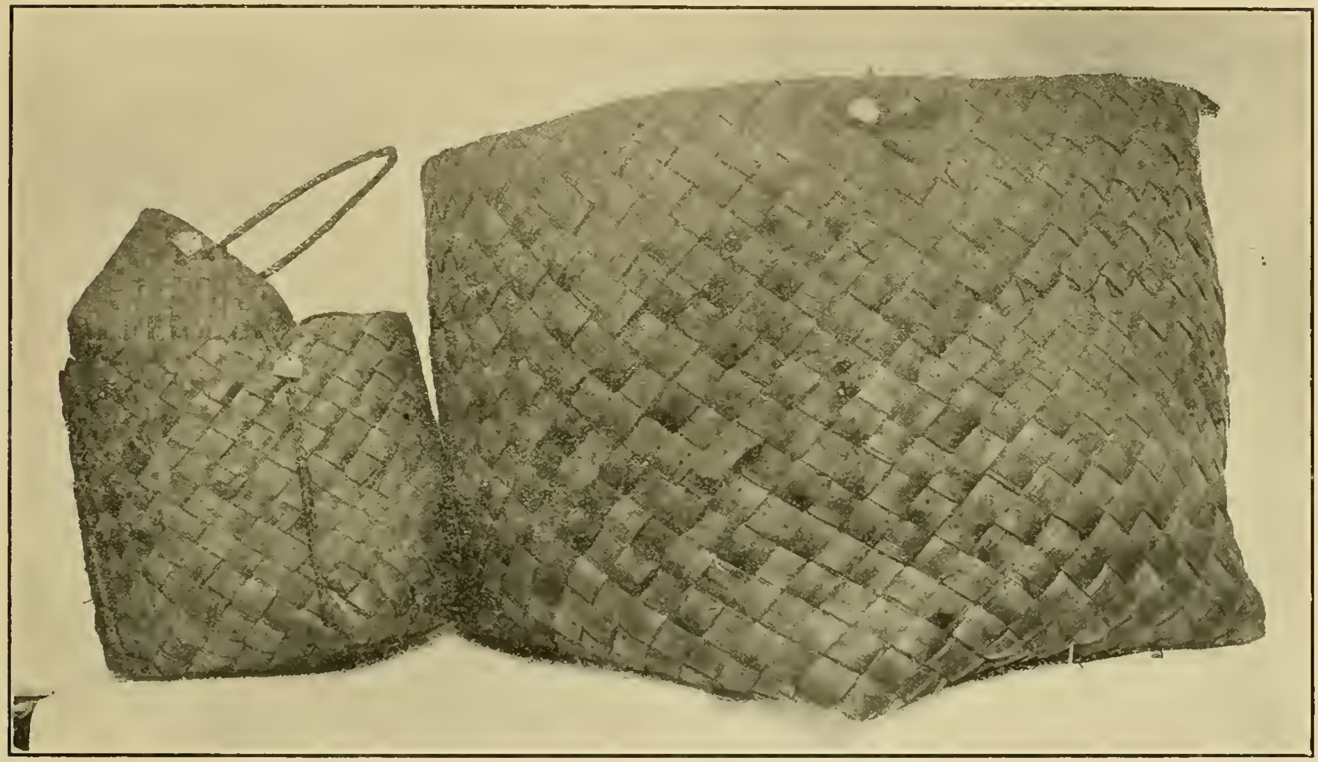


FIG. 45. HAWAIIAN PANDANUS (HALA) BASKETS.

4268. 4.5 in. ☐ base; 5 in. high; woven with ⅜ in. strips.
4266. 8 in. ☐ base; 10 in. high; woven with 1 in. strips; hau braid handles.
4255. 16.5×19.5 in. base; 17 in. high; woven with 1 in. double strip; no handles.
4267. 4.5 ☐ base; 6 in. high; woven with ⅜ in. strip; twisted handle.

The covered baskets of this material were even more flabby and shapeless. They were usually made smaller, and were used much as a modern reticule. They were made in the same form of palm leaf as has already been mentioned, and Fig. 46 shows three baskets of pandanus and one of loulu palm. In modern times this form is made only to sell to visitors, and is rarely seen in use. The baskets shown in the illustration are fair specimens, and I was told by old natives in the early sixties that these were genuine native patterns and not taught by the foreigners. It should be stated in passing that one great difficulty a student of basketry meets in our region where ancient specimens of this perishable ware are not to be found, is the number of braids and patterns taught the natives by foreigners with the laudable intention of improving their manufacture, or in other cases copied without instruction from articles in possession of foreigners. The beautiful flowers made from the stem of the *Tacca pinnatifida*, and the fans equally tasteful, made by the Tahitians, were not native conceptions but were taught by the French Romanist Sisters. The various straw braids used by the modern Hawaiians are another illustration of the foreign grafts. I cannot believe that the primitive forms shown in Fig. 45 are other than purely native invention, and for all I know those in Fig. 46 are equally so. Dimensions and brief descriptions of the baskets of this class in the Bishop Museum are as follow:—

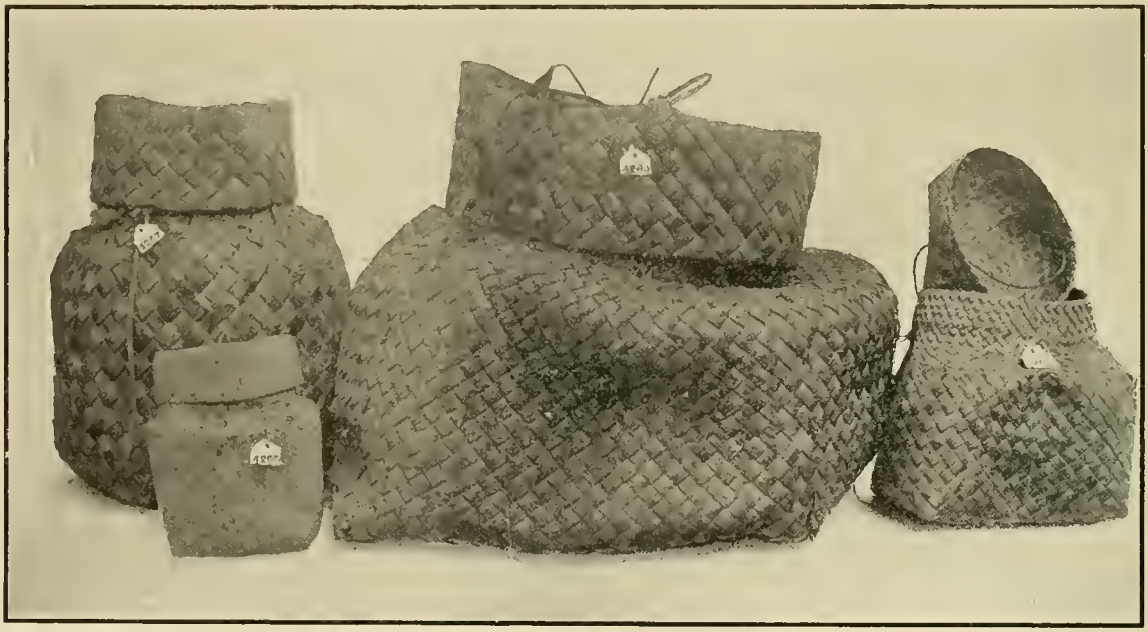


FIG. 46. HAWAIIAN COVERED PANDANUS BASKETS.

4256. Base 8.7 in. □; 12 in. high; cap 5 in. □; ⅝ in. strip doubled on itself to half size where the neck narrows. This is the common way of treating the neck weave and is found in all these examples except one (No. 4263). The handle is formed by a cord attached to the neck; the basket is sewed diagonally on the bottom.

4257. Base 7.5 in. □; 12 in. high; cap 5 in. □; strips ⅝ in.; body of double thickness of strips.

4258. Base 8 in. □; 9 in. high; cap 5.2 in. □; ¾ in. strip on bottom; ½ in. above; hau cord twisted, crossing bottom diametrically inside and up the sides to form the usual two-loop handle which passes through the cap, thus attaching that part to the basket as long as the cords are unbroken.

4259. Base 7.5 in. □; 7.5 in. high; cap 5 in. □; ⅜ in. strip; cords of oloná passed through sides near corners.

4260. Base 4.2 in. □; 8 in. high; cap 3 in. □; strips ¼ in.

4261. Base 6.2×5.5 in.; 7.2 in. high; cap 4×3.5 in.; strips ⅜ in. Single two-ply cord up opposite sides and through cap.

4263. Base 13.5 in. □; 14 in. high; cap 8 in. □; ½ in. strips shaved to half width in narrowing for neck. Cord of braided hau runs through the weave externally diagonally to the corners and up the sides; loose at base of neck and then through cap at the corners. The arrangement of cord handles is shown in the largest basket in Fig. 46.

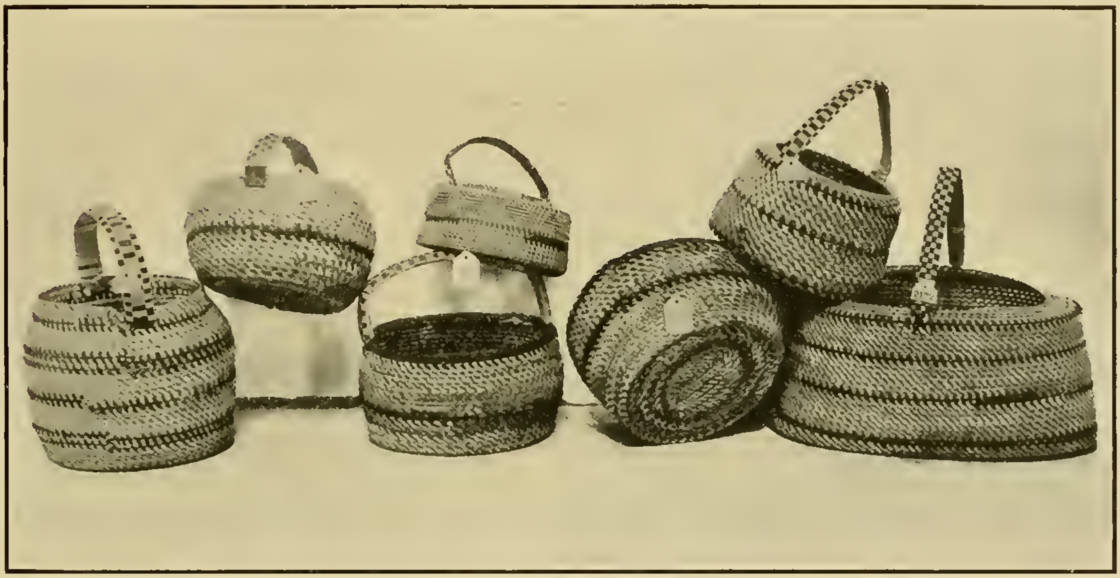


FIG. 47. SAMOAN ROUND BASKETS.

4262. Base 5.5 in. □; 7 in. high; no cap; peculiar as having a red embroidered triangle on each side, and a band of the same just below the neck.

A form of basket in the collection, usually called a fisherman's basket, is of like shape with these last, but has a stiff handle and two small cylindrical pockets attached to opposite sides, but I believe that this form is very modern, and of the three specimens within reach not one has been used. They do not seem well suited to their alleged use.

Samoan Baskets.—As may be supposed other Polynesians made use of pandanus in basket making, and many of those that have come to us are far more artistic than those made by the Hawaiians. At the same time it must be remembered that the examples of the handicraft of the latter are of old time and ancient form, while the illustrations that I shall give are almost all of very modern make by the Samoans and Micronesians, which closely resemble these. As I have reason to believe that the examples from the Caroline Ids., shown in Plate I, Nos. 8081, 4024, are at least close copies of baskets made by the ancestors of the makers of the specimens before us, it may be that the Samoans also copied more ancient examples; but my knowledge of the old basketry of the Samoans is too limited for me to form a just opinion on this. I am inclined to consider the round form of the Samoan basket the older, as it certainly is the cruder stage. This is a fair example of the deficiency of information on the basketry of the Pacific islanders. With the exception of the Hawaiians no serious attempt has been made so far as I am informed, to trace the stages in the basketry of the Oceanic groups; indeed there are few specimens of old baskets from the Pacific in any of the great collections. For that reason I feel justified in figuring the many non-Hawaiian examples, even if I can add but little to our knowledge of them and their place in basket chronology. The figures of Samoan baskets given by Turner[6] do not resemble any in this Museum, but the scale and want of detail may account for that. According to this learned missionary baskets of pandanus were made by the Samoans before they were taught by foreigners.

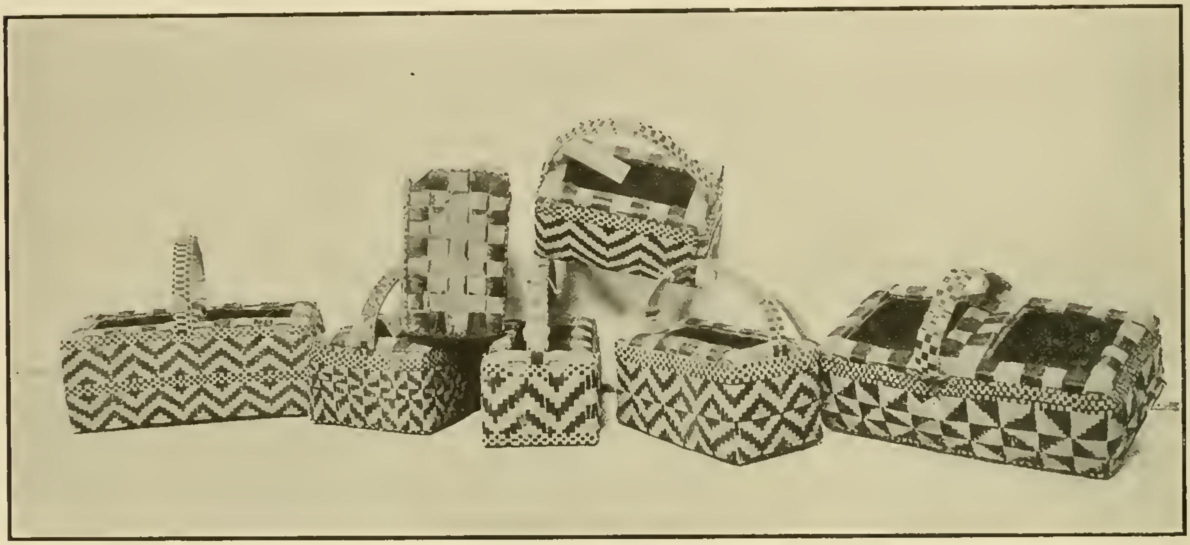


FIG. 48. SAMOAN SQUARE BASKETS.

All the round baskets shown in the figure are of coiled work, the pandanus (fala) being knotted instead of twined. The sizes of the baskets in this Museum are:—

2172. Base elliptical, 11×6.7 in.; 5 in. high; handle flat, checker work; there are four bands of dyed pandanus on the body.

---

[6] Rev. George Turner, LL.D. Nineteen Years in Polynesia, London, 1861, p. 275.

2174. Base 5.7 in. round; 4.7 in high; three colored bands on the body.
2177. Base 6 in. round; 5.5 in. high; rather coarse work.
8190. Base 6 in. round; 3.5 in. high; a green band.
8191. Base 5.7×4.5 in., elliptical; 2.5 in. high; the ornaments and band of red and brown fau (hibiscus) fibre; for ornament portions of the foundation coil are simply wound with the strip and not bound to adjacent coils; handle twilled with red fau and fala.
8192. 6.2×5.5 in., elliptical; height 3.5 in.; two bands of purple fau on the body.
8193. Base 5.7×5.2 in., elliptical; height 3.5 in.; two bands of red fau on the body.

The last four are quite modern and were given to the Museum by Lieutenant W. E. Safford.

The rectangular baskets are of very different structure from the preceding. The coil is replaced by the plain plaited pandanus, and like the round baskets they bear in Samoa the common name of *ato*. The illustration shows both the form, the peculiar inturned edge, and the attractive decoration, but it does not show the double walls found in all of them. The strips are ¾ in. on the inner basket and edges, but on the exterior are much smaller. By the use of black strips a great variety of patterns is shown, but the black has a tendency to fade to a dull red. The sizes are as follow:—

2175. Base 10×5.5 in.; height 4 in.; divided into two unequal compartments.
2176. 11.2×5.5 in.; height 3.5 in.; divided in middle.
3566. Base 7.5×4.5 in.; height 3.7 in.
3567. Base 7×4 in.; height 3.2 in.
6734. Base 5.7 in. □; height 3.5 in.
6735. Base 7×4.2 in.; height 3.5 in.
7949. Base 6.2 in. □; height 3.5 in.
3564. A satchel of similar work and with a flap.

Before leaving the Samoan basketry we may glance at the testimony of several writers as to the methods used by the old Samoans, for they will not fail to throw some light upon the work in similar lines of their relatives on the other groups. It is also interesting to know that in Samoa the basket obtained a sort of vicarious divinity, for on Hawaii a number of gods (*e.g.*, Kukailimoku) were constructed of wickerwork, either plain or covered with feathers. Quoting the Reverend Dr. Turner[7], "Ga'e fefe was a war-god in some of the villages, and seen in a coconut leaf basket. It is said that in a battle between the gods of Samoa and those of Tonga the former crouched about the trunks of the coconut trees; but Ga'e fefe hid in a coconut leaf basket and escaped while many others were killed. Hence the *basket* became a sign of the god, and no one would step over such a thing, supposing the god might be in it. Hence, also, if, in going to fight, they fell in with a newly plaited coconut leaf basket turned upside down it was a bad omen, and sent them back. If, however, the basket was an old one, and not lying *across* the road, but to the one side, and 'fore and aft', it was a good sign and encouraged them to proceed."

---

[7] Samoa a Hundred Years Ago and Long Before, p. 32. London, 1884.

To continue our quotations from the same author (p. 120) in regard to their mats, of which the technic has been recorded more fully, perhaps, than that of any other islanders, he says: "Their fine mats were, and are still, considered their most valuable clothing. These mats are made of the leaves of a species of pandanus scraped clean and thin as writing paper, and slit into strips about the sixteenth part of an inch wide. They are made by the women; and, when completed, are from two to three yards square. They are of a straw and cream colour, are fringed, and, in some instances, ornamented with small scarlet feathers inserted here and there. These mats are thin, and almost as flexible as a piece of calico. Few of the women can make them, and many months—yea, years, are sometimes spent over the making of a single mat. These fine mats are considered their most valuable property, and form a sort of currency which they give and receive in exchange. They value them at from two to forty shillings each. They are preserved with great care; some of them pass through several generations, and as their age and historic interest increase, they are all the more valued." Similar mats used as garments we shall find were made on the Hawaiian group, but of grass rather than pandanus leaf. A portion of one belonging to Kamehameha the Great is shown in Fig. 82, and though more than a century old is still flexible.

Another Samoan missionary, the Reverend John B. Stein, in speaking of Samoan mats tells us:[8] "Of these the most valued were the *ie tau*a, and they might well be prized, since they often occupied five, six, nine and even twelve months in their making. They were made from the *lau ie*, a large plant whose leaves closely resemble those of the pandanus, but are larger. When plucked the prickly edges of the leaves were cut off with a shell, and the leaves then rolled up and baked in a native oven. This prepared them for a second process, which consisted of separating the inner or finer part of the leaf from the outer, the latter being laid aside for a coarser kind of mat.... The finer portions of the leaf were then strung together, fastened to a bamboo pole and placed in the sea, where they were allowed to remain until bleached, a process usually occupying from five to seven days, when they were rinsed in fresh water and placed in the sun to be further bleached, after which, when thoroughly dry, they were cut into little strips of various lengths and widths, according to the fineness of the plait required.

---

[8] Old Samoa, London, 1897, p. 144.

"Upon the completion of one of these valuable mats....all the women familiar with the manufacture of these mats resident in the neighborhood were summoned on a given day to bathe the mat. On the women assembling they proceeded to wash the mat in fresh water, and after well stretching it out to dry they adjourned to the house to partake of a feast provided by the hostess to celebrate the completion of her mat."

How clear the picture of these children of Nature assembling on the bank of one of the many Samoan streams to wash the mat which, after perhaps a year's work, one of their number had finished! They all rejoiced, for was not the work an honor to their village, to their sex, to their friend? And if the customs of both children and domestic animals (dogs and pigs) were then as now, the washing must have been more than an idle ceremony. I am well aware that a Samoan house had a low fence across the doorways, intended to keep out pigs, for on this I have sat while chatting with the inmates of more than one Samoan grass house, both on Upolu and Tutuila; but I also know that in modern times at least it is customary to take the growing mat out under a shady tree where both pigs and hardly less dirty children could scarcely be kept from off it. The washing we may be sure was needed. Our author goes on to say:

"There were also at least thirteen other kinds of clothing, sleeping and house mats made by the Samoans.[9] Various dyes were prepared from vegetables and roots of trees. A beautiful crimson was obtained by mixing the inner bark of the root of the *nonufi'afi'a* (*Eugenia malaccensis*) with sea water and lime. Yellow was prepared from turmeric and oil. It was also obtained from the bark of the *nonu* (*Morinda citrifolia*) previously mentioned. A fine purple was obtained from the young shoots of the mountain plantain, *soa'a* (*Musa fehi*), and a brown by mixing the inner bark of the *pani* (?) with sea water. A black colour was imparted to various articles by burying them in the soft mud of a taro patch formed in a swamp."

Continuing our exploration of the technic of the islanders we find on Fiji, according to Dr. Berthold Seemann,[10] a most trustworthy authority, that "Mats with which the floors of houses and sleeping places are thickly covered, are made of two kinds of screw pines; the coarsest of the leaves of the Balawa (*Pandanus odoratissimus*, Linn.); the finest, of those of the Voivoi (*P. caricosus*, Rumph.). The Balawa, or Vadoa, as it is termed in some districts, is a tree twenty-five feet high, indicative of poor soil, growing in exposed positions, and being one of the first plants appearing on newly formed islands. Its singular habit has often been dwelt upon. The smooth white branches, with their dense heads of foliage, not inaptly compared to the arms of a huge candelabrum; the strong aerial roots, covered with minute spines, and serving as so many props; the curious corkscrew-like arrangement of the leaves, the leathery,

[9] Some of these mats were laufau, lalaga, ie taua, ie 'ula, ie sina and si'aloa.

[10] Viti. B. Seemann. Cambridge, 1862, p. 554.

sword-shaped leaves themselves, and their spiny edges; the long spikes of male, and the shorter branches of female flowers, their delicious perfume strongly recalling to mind that of the vegetable ivory of South America; finally, the bright orange-coloured drupes, formed into large heads of fruit, to say nothing of their insipid taste, appreciated only by natives, are all so essentially different from what a European traveler is accustomed to in his own country, that his attention is involuntarily arrested, and he hardly ever fails to record it. The Voivoi or Kiekie is a stemless species with leaves ten to twelve feet long, which delights in swampy localities of the forests, and is occasionally cultivated to meet the demand. Fans, baskets, and the finest mats—even those on which newly born babes, naked as they are for more than a twelvemonth, are carried—are made of its bleached leaves. Occasionally neat patterns are worked in by introducing portions of the material dyed black, whilst the borders of highly finished mats are tastefully ornamented with the bright red feathers of the Kula—a parroquet (*Calliptilus solitarius*, Latham) not found in the groups eastward of Fiji, and therefore highly esteemed by the inhabitants of those islands."

Turning to the westerly Pacific region, we find in the Solomon Ids., according to Dr. Guppy,[11] still another item in the technic of mat-making. I have not been fortunate enough to see any of the Solomon mats, of which there are a number in the Bishop Museum, that I could feel sure had been treated as Dr. Guppy describes; but his statement is interesting as adding to the methods used in preparing the pandanus leaves. He says:

"Mat-making is one of the occupations of the women of the Straits, the material employed being the thick leaves of a species of *pandanus* which is known by the natives as the *pota*. The leaves are first deprived of their thin polished epidermis by being rubbed over with the leaves of a plant named *sansuti*, which have a rough surface giving a sensation like that caused by fine emery paper when passed over the skin. The pandanus leaves are then dried in the sun, when they become whitened and leathery, and are then sewn together into mats." Evidently the kind of mat already described from the Solomon Ids., p. 32.

In the Gilbert Ids. we learn from the narrative of the United States Exploring Expedition under Wilkes,[12] "The mats are made of the leaves of the pandanus, slit into strips about a quarter of an inch wide, and woven by hand: these are of two colours, light yellow and dark brown: the former are made from the young leaves, and the latter from the old, which are prepared by beating them with a mallet to render them pliable. On the yellow mats they bestow a great deal more of their attention: the young leaves are laid aside for two or three days after they are plucked, till they are withered: they are then roasted by holding them in the hand over the fire, and afterwards laid in the sun for three or four days to insure them being sufficiently dried. During the latter part of the process they are brought every evening into the house to protect them from the dew or rain. When the leaves are sufficiently dry, they are left all night to bleach in the dew: they are then rolled up in balls and pounded with a mallet to render them soft and pliable, and when this is accomplished, they are slit with a shell and are ready for use."

---

[11] The Solomon Islands and their Natives, London, 1887, p. 61.

[12] Narrative of the United States Exploring Expedition during the years 1838–1842, by Charles Wilkes, U. S. N., Commander of the Expedition. Philadelphia, 1845. Vol. v, p. 94.

It may be stated that the pandanus mats of the Marshall Ids. have long been an important article of commerce among the islanders, and the low coral islands of the group are largely dependent on the sale of their mats and the products of the cocoanut for such things as their low and sandy soil cannot produce. Hence these mats are found on most of the groups in the Pacific, and half a century ago they were often brought to Honolulu in the missionary vessels, and I have at times been led to suppose that they were of native Hawaiian manufacture. While the Hawaiians did make similar mats, those of the Marshall and Gilbert Islanders can generally be distinguished from most other products of the mat makers. The mat figured is one of the better class, and measures 11 ft. 2 in. by 9 ft., with a fineness of four to the inch. The dark and light leaves mentioned by Wilkes are very distinct, and by ingenious combinations yield very attractive mats.

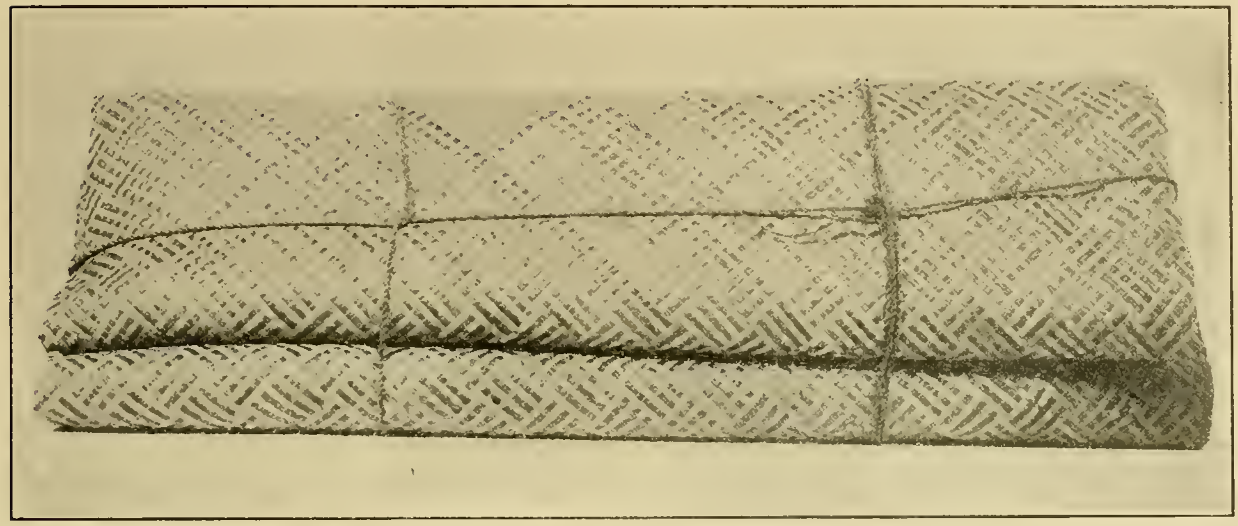


FIG. 49. MARSHALL ISLANDS MAT AS USUALLY FOLDED. NO. 8061.

The custom of keeping fine mats for a long time, using them only on great occasions, seems very ancient, and, if the word of some native Samoans may be trusted, mats several hundred years old are now in existence. The Samoan legend of the origin of one of these mats is sufficiently quaint to warrant its translation here, although it has been translated into German elsewhere.[13] I do not pretend to be a Samoan scholar, but the similarity with the Hawaiian has warranted me in translating the song from the text of O. Steubel.[14] There are expressions of which the meaning can only be guessed at, and even the learned translator into German, Dr. W. von Bülow, has not always been sure that he has guessed aright.

There are several versions of this story; the present one was collected at Safune, and Dr. von Bülow gives another not very different, in the volume referred to. The story is in genuine Polynesian form, and serves to explain the reverence with which certain fine mats are to this day preserved by the Samoans, wrapped in *siapo* and carefully stored among their choicest treasures.

O LE TALA I LE IE.

O Neefanua ma si ana tama o le pipili ma lona tuagane o Uu (Vaiuu) ma o Ololua (Lolua): ua sau la latou vaa mai Fiti ma lalaga mai i ai o le ie i le vaa.

Ua maua o le igoa o le ie o le Lagavasa.

Uua taunuu ai i Siuutu i Salailua, ua toe lalaga ona toe sauni lea a oo mai i le Itu o tane.

Ua lalaga o le ie, ua pipii ma le eleele.

Ona faaigoaina lea foi o pipii ma le eleele.

Ona fua lea.

Ua sau o le vaa i gatai o Safune.

Ua fai atu Uu, sei nofo o le vaa i tuaau, sei asia o le nuu nei po e i ai o se latou ava.

Ua alu ai Uu, ua tui le ava.

Ona alu ifo lea ona fai atui, oomai ia ua maua o le ava.

Ona alu ai lea o le vaa ua ofi i uta.

Ona fai atu lea Uu, oomai ina oo i uta: au fia nofo i si ou ava.

Ona ua nofo ai Uu ua faatupu maa i totonu o le ava, e i ai o le maa i nei onapo i le ituava sasae.

Ua alu ai o le vaa, ua tuuta i uta, na taunuu ia Tugaga; ua tulia;

Ona alu ane e moe i le fuefue.

Ona toi igoa ai o le ie Ua moe i le fuefue.

Ona latou oo lea i le Ituvai i sasae, ua latou oo i Asu, ua lalaga foi o le ie: ua oo i onapo o le tuaoloa, ua agimai o le matagi, ua sau o le oneone i le fale, oneone ai o le ie. Ona tata lai lea o le ie, ua asuasu, ona faaigoaina lea o le maota o Asu, i le asuasu o le ie.

Ua oo o le malaga o le alii Lealatele o Tanuvasavasamanaia, ua afe i le fale o le Pipili i Safuné.

Ua avaga o le Pipili ia Tanuvasavasamanaia, ua fanau o Tualafalafa o le teine.

THE TALE OF THE MAT.

Neefanna with her daughter the cripple (hunchback) and her brothers Uu and Ololua came in their canoe from Fiji, and she plaited a fine mat in the canoe.

Then was given to the mat the name Lagavasa (woven on the high sea).

They made land at Siuutu in Salailua and wove the mat again and traveled to Itu o tane.

She wove the mat and the dirt clave fast to it.

For this was the mat named Pipii ma le eleele.

More leaves were to be collected.

The canoe went on to the seaward of Safune.

Then spake Uu, "The canoe must rest on the other side of the reef and a boat-passage must be found in the reef."

Then went Uu to pick out a boat-passage.

He returned and said, "Come, there is a boat-passage at hand."

Then went the canoe through the reef to the land.

"Now," said Uu, "Come, go you ashore while I stay by my boat-passage."

Then stayed Uu there and raised up a stone on the inner half of the entrance, that very night, a stone on the east side of the passage.

The canoe made land and was drawn up on the beach, it came to Tugaga; they went onward.

She went thence and slept in the bush.

From this was the mat called "Ua moe i le fuefue."

She went then to the east side of the stream, and turned to her mat-weaving again. Then arose in the night the southeasterly wind and blew the sand into the house so that the fine mat was full of sand. Then was the mat shaken: thence came the name of the chief's house, "Asu," from the shaking of the mat.

The chief Tanuvasavasamanaia of Lealatele was journeying and came to the house of Pipili at Safune.

Then Pipili married Tanuvasavasamanaia and bore him a girl, Tualafalafa.

---

[13] Archives Internationales d'Ethnographie, xii, 136.

[14] Die Leute des Tagaloa, p. 144.

(Ua e i ai i nei onapo o le ala o le Pipili i Safune.)

Usu mai o le alii o Faitala mai Atua ia Tualafalafa, fanau Sina fafaga i tua. Usu ifo o Aoee i luga i le lagi ia Sinafafaga i tua, fanau Sinamaa Aoee.

Ona gasegase ai lea o Aoee, ona feauina ifo lea o Sina maa Aoee e alu ai i le gasegase o lona tama; ua faaputu toga ua ootai o le teine i lona tama, aua o le gafa ua ta i le lagi.

E i ai o le upu, "O le gafa ta i le lagi."

Ua fai toga. A ua muimui Tualafalafa, aua ua leai soona faitoga; a afiifii lava i le aluga o le ie, ua igoa tele.

Ua oo i le aso na tele ai toga, ona tatala loa lea o le ie:

Ua uila ma pogisa ma faititili ma afa sasa ia o le ie.

Ua ofo o le toatele o tagata, ua latou faaigoa ai o le ie ia Tasi e afe.

O le uiga o lenei igoa: Ua tasio le nei ie, a ua afe toga ua manai.

Ua tea i le lagi o le ie.

Sa tepa ifo nei o Sina maa aoee ia Tooalo i Manase, ua to tigapula, ua sili i le tua o se ie ula.

Ona tagi ai lea o Sina maa aoee i lona tama, ona oo ane i ai lea o tama toalua o Ale ma o Ua faafuasei late momolia o le teine i le alii, ua fia fai tane ai.

Ua to o Uafaafuasi, tago loa Tooalo, sei o le ie ula e tu i lalo o le maa, a tu loa o le teine o Sina maa aoee, ua tepa atu, ua leai o se ie ula; ona fesili lea o le teine:

Alii e, oifea o le alii, sa totoo lona tigapula?

Ua tali atu Tooalo; O au lava lenei.

Ona oso ai lea o le teine, o lea e au i le vai, a ua afisi i lona aoao o le ie.

Ua tatala o le ie, faa ua susu.

Ua iloilo, ua mago lava.

Ona faaigoaina lea o le ie ia Matumaivai.

Ua nofo Sina maa aoee ia Matilafoafoa, ua fanau o Sinataeoilagi.

Usu Tooalo ia Sinataeoilagi, fanau Sinaautuimo.

Usu mai Leuluialii ia Sinaautuimo, fanau Muliaga ma Matagitausulu.

Usu mai Tuisamoaia Matagitausulu, fanau Nonumaufele.

(There is to this day in Safune the street of Pipili.)

The chief Faitala mai Atua married Tualafalafa and begot Sina fafaga i tua. Aoee came down from heaven, married Sinafafaga i tua and begot Sina maa Aoee.

Aoee was ill, and Sina maa Aoee was sent down from heaven to cure the illness of her father: fine mats were collected, and the daughter goes to her father; so it was the genealogy towered toward heaven.

Thence comes the saying, "The genealogy is from heaven."

Mats were collected and Tualafalafa murmured because her mat had not assisted. Therefore was the mat with many names made into a pillow.

As now many fine mats were collected, the mats were lying unfolded.

Lightning and darkness, thunder and hurricane were the omen of the mat.

Astonished were the people, and they called the mat "One of a thousand."

The meaning of this name is: One is this mat, a thousand would balance it.

The mat so came to heaven.

Then looked Sina maa aoee upon Tooalo in Manase, he was planting a taro top and wore on his back a red (feather) mat.

Then did Sina maa aoee call to her father, and he brought two youths, Ale and Uafaafuasei, for the maiden longed to get the chief for a husband.

Then fell a sudden rain and Tooalo caught hold of his feather cloak and hid it under a stone; then at once stood the maiden Sina maa aoee before him and beheld him without the red cloak; then asked the maiden:

"O Chief, where is the chief who plants taro?

To her replied Tooalo, "I am he."

Then plunged the maiden into the water, and swam through the stream, taking the mat in her armpit.

Then was unloosed the mat, lest it be wet.

It was examined and found quite dry.

Then was the mat called Matumaivai (dry in the water).

Then Sina maa aoee dwelt with Matilafoafoa and Sinataeoilagi was born.

Tooalo married Sinataeiolagi and begot Sinaautuimo.

Leuluialii married Sinaautuimo and begot Muliaga and Matagitausulu.

Tuisamoa married Matagitausulu and begot Nonumaufele.

We can picture to ourselves the Samoan woman sitting beneath the shade on the bank of a stream singing this ancient song as she, too, tries to weave the fine mat which may be kept in memory of the maker long after her earthly pilgrimage had ended. The red mat in the song is supposed to be covered with the feathers of the Fijian *Calliptilus solitarius*, Latham, feathers greatly valued but not found on Samoa. The father of Sina maa aoee was the rain god, hence his sending of the lesser gods to pour the sudden shower which caused Tooalo to hide his precious cloak from the rain.

Mat Sails.—In the Director's Report for 1899 (p. 25) is an essay on the Mat Sails of the Pacific, by Mr. John F. G. Stokes, now Curator of Polynesian Ethnology in the Museum. This is a very complete and accurate compendium of what is known of the ancient sails, and as these were generally made of pandanus mat by a method of weaving differing from that used in the construction of the broad sleeping mats, we may quote here that portion relating to this work: "The sails throughout Micronesia were always made in strips varying in width from four inches to three feet, the Micronesians being particularly apt in this form of mat-making. The Marshall Islanders, who are among the most expert canoe builders and sailors in the Pacific, use a lapboard, cut from breadfruit wood, on which the mat is woven (Fig. 50). The board is arched and sets very comfortably in the lap of a person sitting on the ground. The

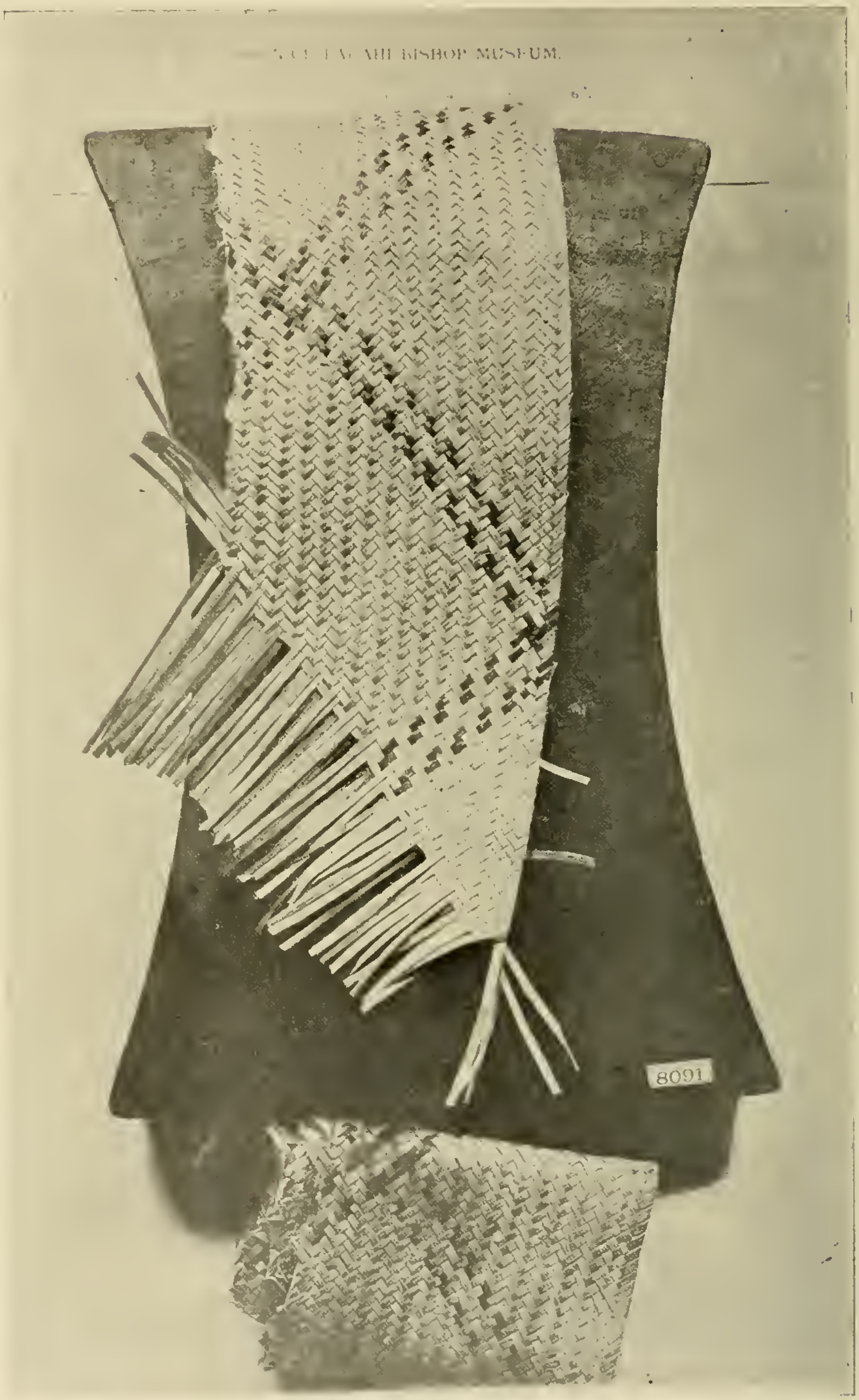


FIG. 50. LAPBOARD AND STRIP OF MAT SAIL.

strips of matting as woven are passed from the board and neatly rolled up. The strip of mat has four dark strands of dyed hibiscus fibre woven in on top of the usual strands of pandanus; this is a favorite method of ornamentation among the Marshall Islanders. The weaving commenced on the left side, and the strands were cut to about twenty inches in length, being long enough to pass around the three strands of pandanus used to form the border at the right and reach the left edge again, where after being woven in about half an inch, they were trimmed off. It might be noticed that at regular intervals along the left-hand border some strands were allowed to protrude; at this edge, as stated, the fresh strands were applied, and when secured four ends out of every seven were trimmed off, the three remaining butts being left to guide the weaver in inserting the black ornamental strands. This strip is 4.7 in. wide, while the breadth of the strands varies from 3/32 to 1/8.

"Having woven a great length of sail mat the strips were placed together with edges overlapping and sewed with a thread made from coconut fibre or twisted pandanus, the edges of the strips, on the edges of the sail being turned under and double sewed with the coconut fibre, which material is also used to bend the sail to the spars. A sail made in this fashion is very strong and will stand a great strain. It is about twice as heavy as an ordinary mat, and little heavier than canvas, and if wet becomes dangerous to use if suspended from the mast. The Micronesians, in a rain storm, prefer to lower the sail and roll it up in an envelope of pandanus or banana leaves which they generally carry for that purpose. The Hawaiian sail was made in strips, but that of Tahiti seems to have been composed of several large square mats sewn together, and could not have been a very strong combination. In all cases the work of weaving devolved on the women, while the men attended to the sewing and shaping of the sail."[15]

Narrow strips of matting like those made for sails were woven by the Samoan women for the game of *Lafoga* (pron. lafonga), in which it served as a sort of alley. These mats were about 7 in. wide and 17 ft. long. Two of these mats and a complete apparatus for playing this interesting game of skill are in the Bishop Museum, the latter the gift of Lieutenant Edw. E. Goodhue, U. S. N.

Satchels of Pandanus.—A form of pandanus weaving from Micronesia and Fiji must now be noticed, of which there are examples in most large museums. Four from the Gilbert group are shown in Plate II, Nos. 7096, 7095, 7094 and 3349, and there it may be seen that they are formed like the mats previously described from Ebon, of broad leaves which are split in places to receive the small black strips which serve both as ornament and binding.

I do not know the exact use of these satchels, and the carrying capacity of those from the Gilbert Ids. is very small. They come to the Museum labelled "Basket for books," and if this is their only use their origin must be recent, for it is not many decades that these islanders have had any books to put into them. On the other hand those of similar shape from Fiji are certainly ancient, some specimens in the old Marine Museum at Salem, Massachusetts (now Peabody Academy of Science) dating from the early years of the last century when the cannibals of that group had no books.

---

[15] Occasional Papers, vol. i, no. 2, p. 26.

While all the satchels in this Museum from the Gilbert group are made of broad leaves sewed together and not interwoven, the embroidery of black or red strips being inserted by splitting the leaves as needed and after the basket is put together, those from Fiji are genuine mat work with broad strips, the embroidery being by the same method in both cases. In the Fijian satchel, No. 8198 (Fig. 51), the small strips inserted obliterate the irregularities left by the alternate raised and depressed squares in the weave of the satchel and leave a uniform surface. This is especially noticeable in the band along the upper edge. In the Fijian satchel the bottom and edges are continuous and not sewed as are the bottoms of those from the Gilbert Ids. There is a fine series of the Fijian satchels in the Salem Museum, better, I believe, than elsewhere. The dimensions of these satchels in the Bishop Museum vary considerably and are as follows:

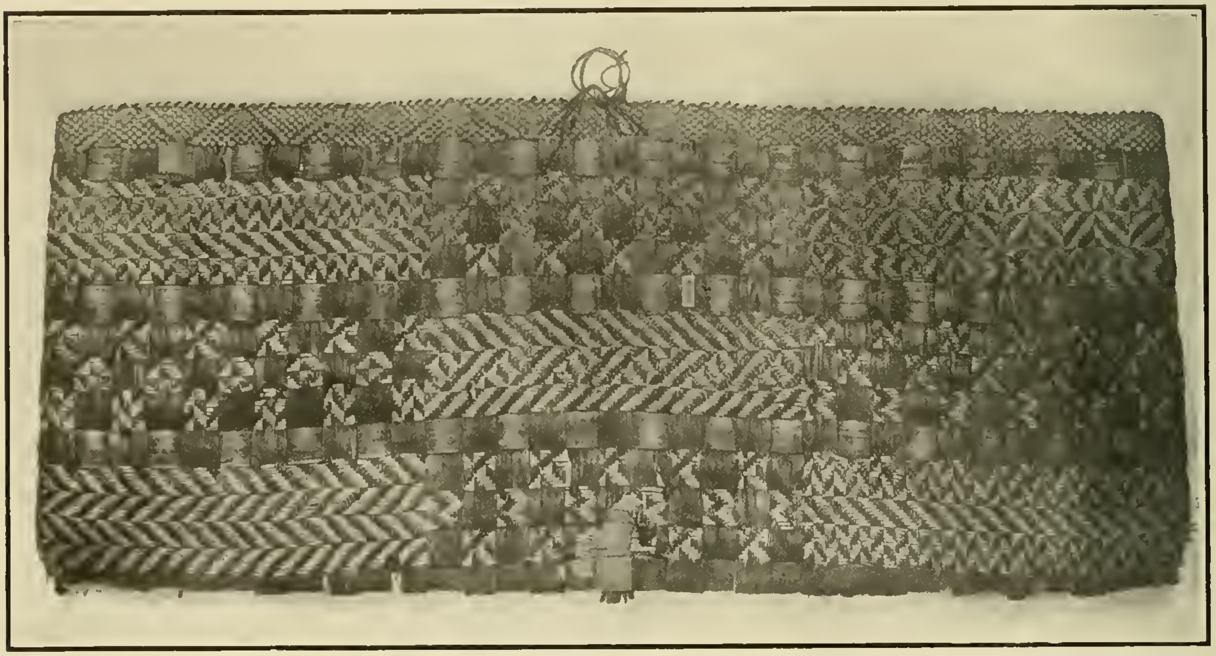


FIG. 51. PANDANUS SATCHEL, FIJI.

8349. 8.5×7 in.; coarse; upper border of finer mat work. Gilbert Ids.

7094. 6.7×6 in.; a continuous band sewed at bottom, and bound at top; red and black strips. Gilbert Ids.

7095. 12.5×6.5 in.; a double thick folio sewed only at bottom; has two bands of embroidery. Gilbert Ids.

7096. 11.2×9.2 in.; continuous band, sewed at bottom; two bands embroidered. G. I.

8198. 34×14 in.; woven with inch strips; inside plain; outside mostly covered with embroidery. Fijian.

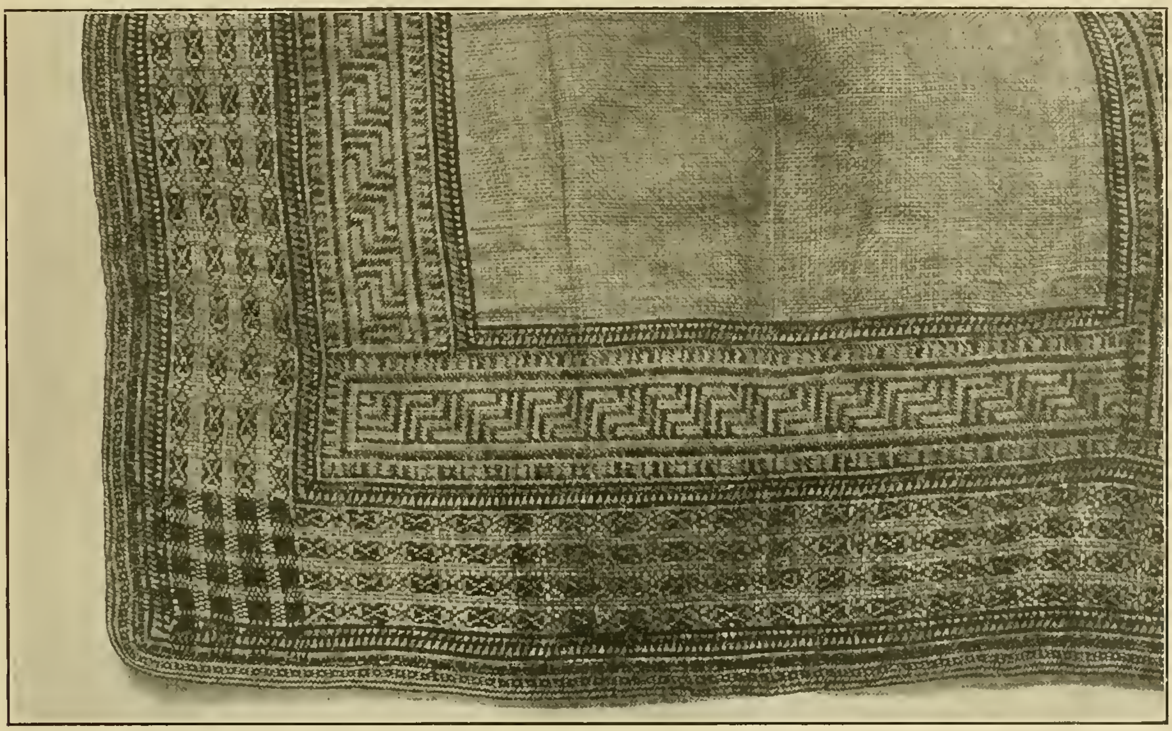


FIG. 52. MARSHALL ISLANDS MAT.

The Fijian specimens at Salem vary in length from 32 to 17 inches. In style of decoration they are well represented by the specimen in this Museum, already figured.

Mats for Clothing.—Although the Hawaiians certainly used mats for clothing, not only as wraps, but as waist cloth (malo), the principal development of clothing made of mat work, that is woven of grass or leaves instead of finer fibre, was on the Marshall Islands. The beautiful work of these islanders is familiar in all museums, and much has been written about their manufacture and use. I do not here intend to treat these mats from the point of the designer, for the various bands shown in the figures here given have names and appropriate uses. For all these I must refer the student to the most complete account known to me, that of Prof. Dr. Augustin Krämer;[16] but for the technic of the mat making I shall take the liberty of translating from this interesting paper. As the orthography of the names of the mats and their parts seems wholly unsettled, even German writers not agreeing among themselves, we may pass over the native names and their etymology. The illustrations given here of these mats are all from the Bishop Museum collection, except Plate V, which is made from a large mat long used as a table cover by the writer, who has thus had an opportunity to test the durability of these admirable mats. Nearly all here figured differ more or less from those figured by Dr. Krämer, and many of them are of considerable age.

I translate freely from Dr. Krämer, omitting much of the philological matter as, however interesting and valuable, foreign to our present purpose.

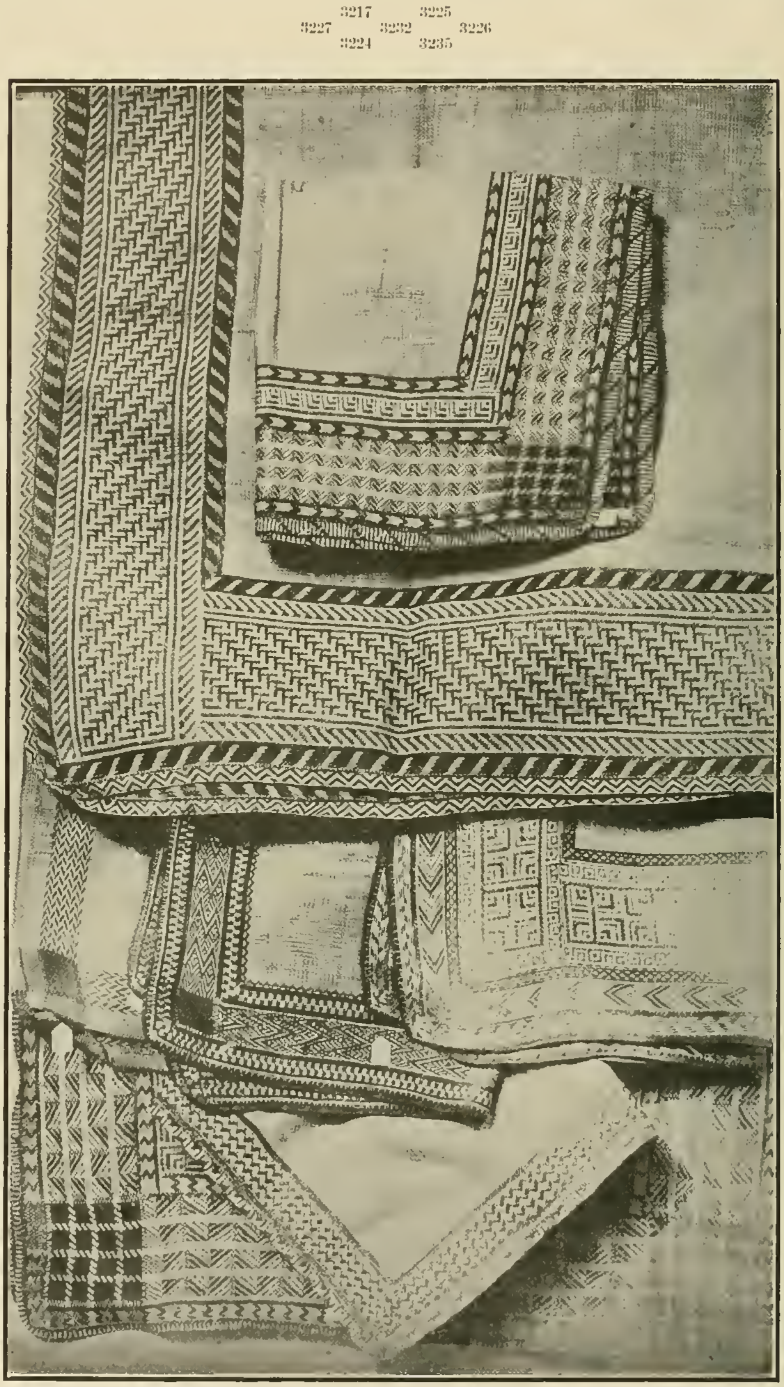


FIG. 53. GROUP OF MARSHALL ISLANDS MATS.

"Among the productions of the Marshall Islanders doubtless the mats used for clothing take the first place.... These were made freehand without apparatus or loom, only a long pointed weaving needle, called *oca*, generally from the long wing bone of the albatross, serves to lift up the strands which are woven on a lapboard of breadfruit wood one to two feet long and six to twelve inches wide, called *digenat*. [A similar one is figured in the section on Mat Sails, p. 46.] For the embroidery a needle of human, dog or fish bone; for trimming the leaves a pinna shell, *djabor*. All these things are kept in a basket woven from coco leaves called *bodjo*. For the mat the leaves of *Pandanus odoratissimus* are used. For the fine mats these are plucked young and roasted over a fire; for sails or coarse mats the older leaves are selected and left to dry in the sun, and then beaten with a hard mallet, *draggeinia*, of *Tridacna* shell [see No. 7832, Fig. 54]; the beaten leaves are rolled into bundles [like those shown in Fig. 38] and laid aside for occasion.

---

[16] Die Ornamentik der Kleidmatten und der Tatauierung auf den Marshallinseln nebst technologischen, philologischen und ethnologischen Notizen. Archiv für Anthropologie, Neue Folge, Band 11, Heft 1. Braunschweig, 1904.

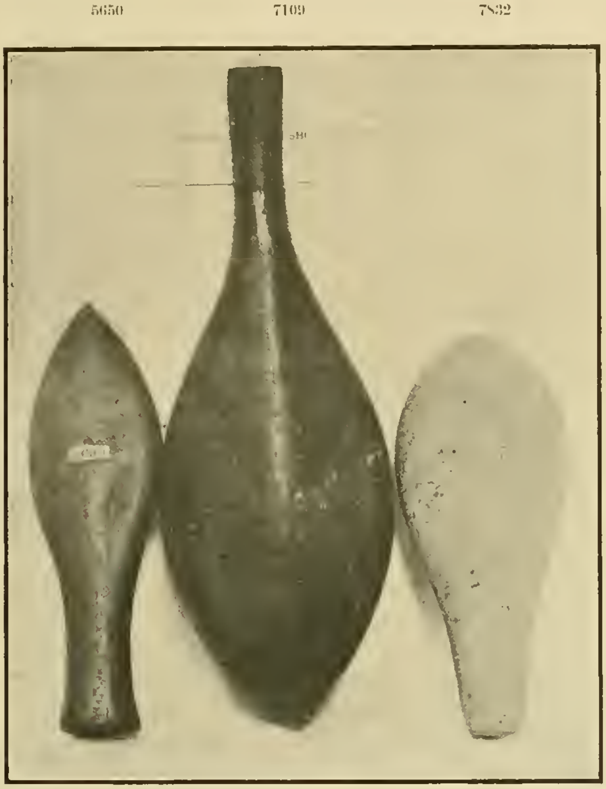


FIG. 54. MALLETS FOR BEATING PANDANUS LEAVES.

"When the weaving begins, leaves are taken four inches wide and three to seven feet long, and slit into strands which have various names according to their width, as *ajelar*, three fingers wide, *ajennen* thumb-breadth, *djelerik* still thinner (3/16–5/16), and *rua* the finest (1/16–3/32). The red fibres are from a creeper, *Ficaria ranunculoides*, called *adad*. The bark of the thinner shoots is stripped off, scraped and freed from the epidermis and dried; the bast then assumes a brown or reddish-yellow hue. The black fibres here, as on other islands, are from the bast of Hibiscus dyed with soot or mud. According to Finsch the black dye is obtained from the fruit of the mangrove. These are grated and boiled in marine shells or coconut shells and the bast is soaked in the decoction until the desired tint is obtained. For a red color the same strips are passed through a dye made of the root bark of a certain tree (*Morinda citrifolia ?*) with the addition of lime."

After describing the sleeping mats, which were arranged much as in Hawaii, the coarser weave at the bottom and the finer at the top of a pile often four to six inches thick, the bottom ones being sometimes of coco leaf, Dr. Krämer describes very fully the fine clothing mats, of which class we have illustrations before us. (Figs. 52-3.) It is unnecessary to go into the analysis of the ornament with the Doctor, but his explanation of the way of wearing these rather uncouth garments, which are fast giving place to the foreign cloth loose gowns, may well be noticed. There are two distinct ways of wearing them: either two mats, one in front, the other behind, are worn as aprons and fastened around the waist with a coil of the interesting coco and pandanus cord already described, a coil that is often sixty feet long (and Finsch reports one fifty metres long), or a single mat is passed between the legs and the corners brought over a similar girdle forming a sort of malo, an arrangement that would seem to preclude any rapid running by the wearer.

The thickness of the cord girdle increased with the rank of the wearer. There were also in these mats (called *ir*) patterns suited for men, others for women, some for commoners, others for chiefs, all of which Dr. Krämer fully describes. These mats were often given as presents, and in the early sixties some of the Marshall Islanders made a large one suitable for a bed cover which they sent as a present to Kamehameha V in recognition of the good done for them by the missionaries from his kingdom of Hawaii. On the voyage from Micronesia to Honolulu rats destroyed a corner of the elaborate border, and the partial ruin was purchased by the writer and is now in the Peabody Museum at Cambridge, Mass. When the use of mats for garments ceases, as it will very soon, it is questionable whether they will still be woven. For table covers they are well suited, as well as for other purposes of domestic ornament or use, and it would be a pity that they should be relegated to the class of lost arts. It cannot be denied that mat weaving here, as elsewhere in the Pacific, is rapidly declining, owing largely to the unwise method of instruction that has been in vogue throughout the Pacific where the methods of Anglo-Saxon education have been forced upon peoples generally unable to assimilate such intellectual food. If the white men had simply endeavored to make better specimens of the various races, saving what was good in their work, gently eradicating the heathen tendencies, it seems possible that many of the useful industries of the Pacific might have been saved from the list of abandoned arts. The pandanus and makaloa might still be fashioned into fabrics which would bring revenue to the makers and credit to the islands of the Great Ocean.

Hawaiian Lauhala Mats.—Enough has already been described of the methods of other Pacific islanders perhaps to render superfluous any minute description of the ways and means of the old Hawaiians in lauhala mat making. Doubtless it was the oldest form of mat making on these islands, and fragments are found in the most ancient burial caves quite like the mat work of the present day. No such work as that just described from Micronesia was made here, perhaps because the use of kapa for garments rendered their use for clothing unnecessary; but it must not be supposed that the old Hawaiians did not make fine pandanus mats, for there are sufficient witnesses to the fact in the cases of the Bishop Museum, where most beautifully regular and finely woven mats are in considerable number.

As to the legendary origin of Hawaiian mats I can give no information. Not only have the modern natives preserved no remembrance of the songs or legends of any such theme, but unfortunately the present writer neglected to take down from the lips of the old women who, in the middle of the last century, were singing such songs as they plaited the mats in the Puna caves, songs which undoubtedly related to their early predecessors in the mat making work; he also neglected to ask what were the tutelar gods of the craft, and today the remaining natives are unable or unwilling to give the ungathered information. We only know that the Hawaiians had among "the forty thousand and four hundred thousand gods" one or more especially worshipped by the pious artisans in basketry of former days. We also know that they had songs and legends of early mat or basket makers who were famous at their craft, and were perhaps apotheosized by their successors for their skill. The teaching of a new religion seems to have driven from their thoughts many things worth remembering while by no means strangling the superstitions of the neophytes. Their love for the recital of *mele*, which was quite oriental and kept alive in their memories the doings of their forefathers, their genealogies, and the rules of life, has largely disappeared from this group, and aimless political discussion or modern tales of a very different nature have usurped its place.

Leaving then the folklore and poetry of the basket and mat makers untold, we must present their work, which is so like that of all the other Polynesian groups that it hardly deserves an extended paragraph. The hala leaves were gathered, they were dried either in the sun or in the cover of the house, were scraped, trimmed and beaten, then rolled and stored until enough and more had accumulated for the intended mat. The shell trimmer was that used everywhere, but the mallet was not like those figured from the Marshall Islands (Fig.54), but either a plain round club (*hohoa*), or more commonly an old kapa beater (*ie kuku*), of which the engraved sides had become smooth from long use. These four-sided clubs with rounded handles were common all over the group, as they were necessary utensils in every family, and they are to be found in most ethnological museums.

I have asked a skilful maker of lauhala mats, still resident in the once famous mat making district of Puna, to make for me the first few inches of a common mat, and the result is shown in Fig. 55. To show her good will as well as skill she has embroidered her own name and address on the obverse of the figure, and my name on the reverse; but in spite of that fancy the specimen shows perfectly well the beginning of the weaving. No vestige of a loom, not even pegs to hold the row of leaves in place is needed, but a sufficient number of hala leaves is taken to cover the width of mat desired, and these are strongly sewn together as shown in the figure. The splitting into strands of the selected width is then done and the plaiting begins. Each strand passes diagonally to the edge of the growing mat and then turns and continues its journey at right angles to its former course until it reaches the other side, or is continued by a succeeding strand which is neatly inserted under the overlapping transverse strand. The skill with which the weaver keeps the long strands from hopeless entanglement and puts each in its destined place is surprising to the uninitiated. To the success of the mat the weaver's fingers must put the right tension on each strand or the mat will be bellied or warped, and will not lie flat or be rectangular when finished. An inexperienced or careless mat maker is always known by the irregular mat. While the whole leaved edging is sometimes left on the finished mat, it is usually cut off when the distal end has been bound in.

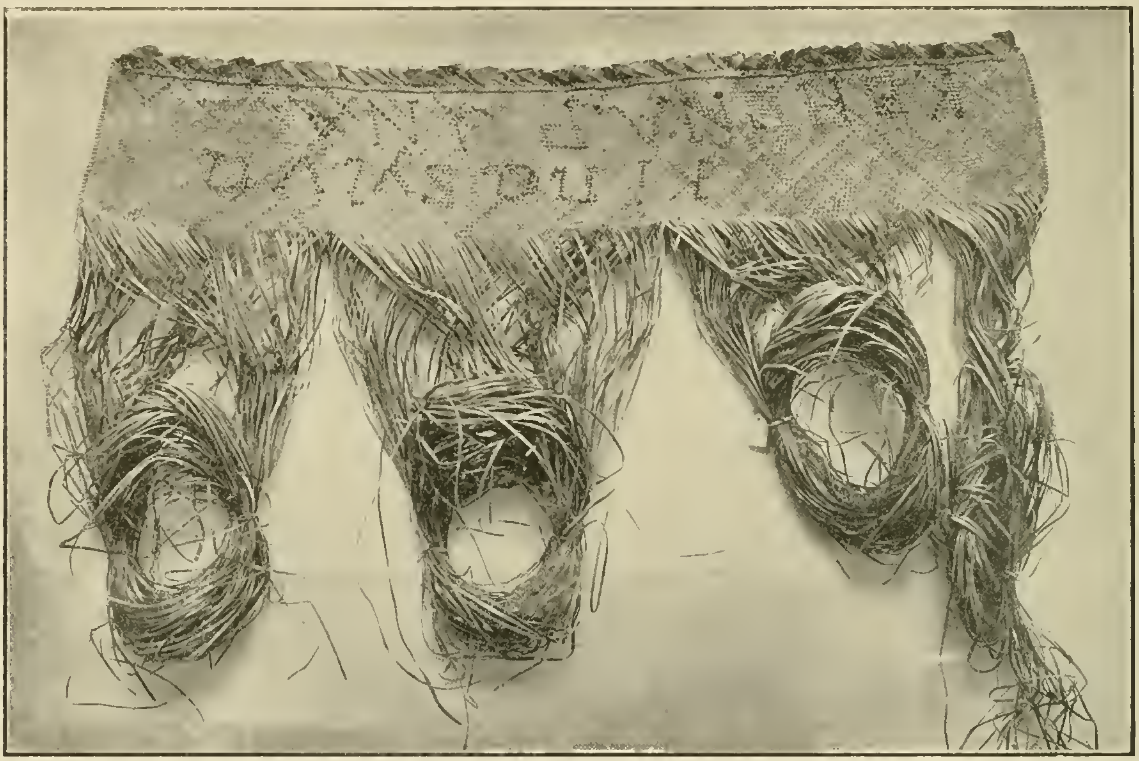


FIG. 55. THE BEGINNING OF A MAT OF LAUHALA.

The size of these mats was unlimited, except by the use to which they were destined. Often they extended quite across the house, and when intended for covering canoes might be eighty to a hundred feet long. Long and narrow ones were used for a table at an *ahaaina* or feast; a moderate sized one in the Bishop Museum, made for this purpose, measures 3 ft. in width and is 28.7 ft. long (No. 2583). It was not uncommon to weave in coarser mesh or strand immense mats to spread on the ground for seating a large company, and I have seen in old native churches mats many yards square covering the whole floor, there being no pews or seats of other nature. From their size and weight they were seldom removed, and often became unsanitary, according to modern ideas.

The bed mats have been several times referred to, but they may be more fully described here as a series of mats woven, in the best houses, to fit an allotted place, and arranged in accordance with their fineness from the coarsest, which rested on the gravel floor of the house, to the fine mat on top that showed the wealth or taste of the owner. To keep the mats in place (and as the whole family slept on the same bed, and some of the bedfellows might be uneasy from overfeeding, this was no simple matter) mats of the *hikiee* were sewed together along one edge, and this edge generally raised by the interposition of strips of the same matting.

Matting of the lauhala in coarse weave, one inch strands or larger, were in constant use to cover property from the sun or sudden showers, to spread nuts or herbs upon while drying in the sun, and to wrestle on in an indigenous form of that manly exercise, where the contestants clasped hands and, without touching any other part of the body, endeavored each to push the other off the mat. In the early days of the American Mission on these islands the simple homes of the missionaries were generally carpeted, if at all, with lauhala mats woven to fit the room, and examples are still extant of mats of great beauty given by early converts to their respected teachers.

New Hebridean Dresses.—On several of the islands of the New Hebrides, a group using the loom, and famous for fibre weaving, are found dresses of finely cut pandanus, so closely resembling grass work, that until the material was considerably magnified the author was inclined to class them with the makaloa mats of the Hawaiians. As will be seen in Fig. 56, they are aprons of no generous size (some are hardly two inches wide), but the peculiarity of their openwork weave recalls the Tongan mats of the opposite side of the Pacific. These aprons are worn by the women by means of some sort of belt, and on some of the islands are stained a magenta red which does not add to their beauty in the eyes of a foreigner, and almost conceals the openwork patterns. Some of those from Malekula have been washed until the pandanus fibre is broken and roughened. The following list of women's dresses from Malekula, Oba and Ambrym shows the difference in size:

8143. 3.2 ft.×10 in.—16 strands to inch. Malekula, twilled weave, no coloring; Fig. 56, No. 3.
8144. 3 ft.×9 in.—15. Malekula, plain weave; Fig. 56, No. 1.
8145. 3 ft.×11 in.—14. Malekula, twilled; Fig. 56, No. 2.

8447. 3 ft. long×9 in. wide—20 strands to inch. Oba, with various openwork designs at ends, and stamped with magenta stain.

8448. 3.2 ft. long×9.5 in. wide—20. Oba, like last, short fringe on edges, long on ends.

8449. 1.5 ft. long×3 in. wide—26. Ambrym, broad red stripes, openwork ends, with long (10 in.) fringe.

8459. 3.7 ft. long×1.7 in. wide—21. Ambrym, all red, two sewed together in the middle, ending in four braided tails and long fringes.

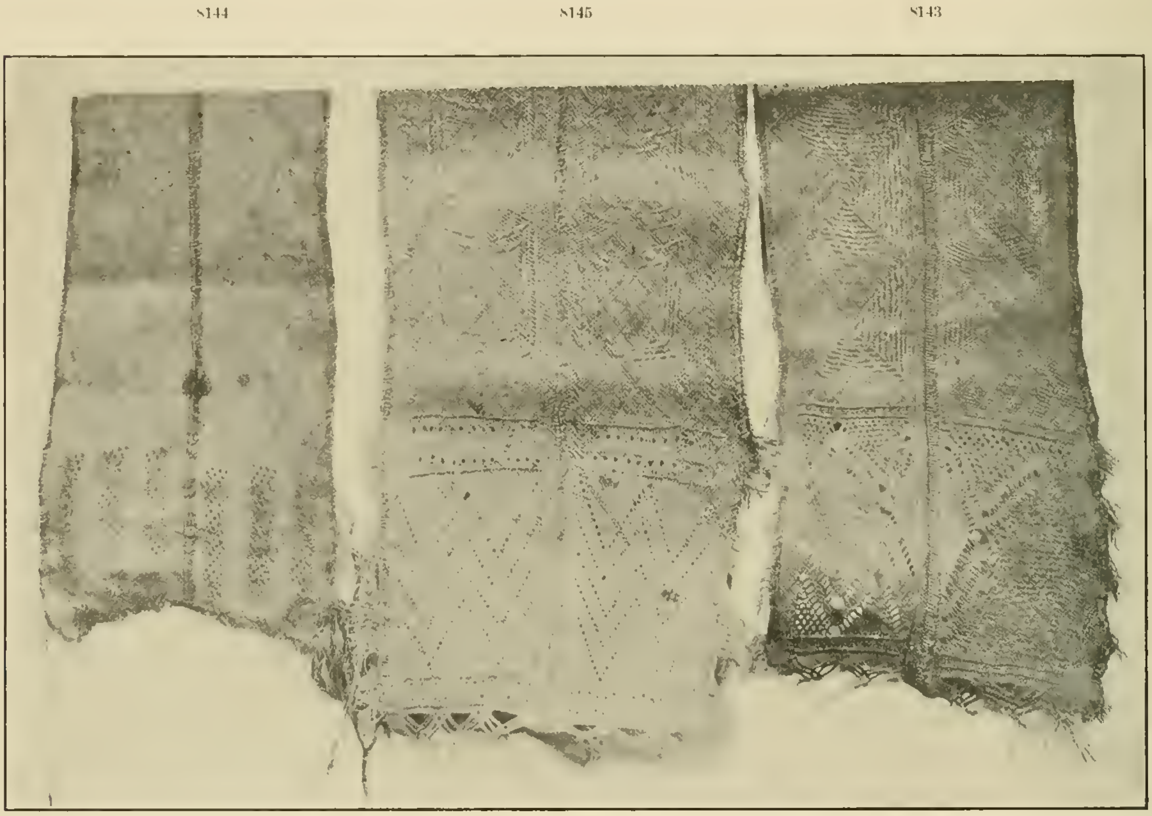


FIG. 56. WOMEN'S DRESSES FROM MALEKULA, N. H.

6627. 3.5 ft. long×10.5 in. wide—15. Oba, openwork ends, stamped purple all over, fringes.

6628. 3.6 ft. long×11.5 in. wide—16. Oba, same treatment as last.

Fijian Coffin.—This remarkable specimen of basket work is 22.5 in. long, 9 in. wide in the middle, 5.5 in. at the ends, and 9 in. deep. The bottom is wholly of breadfruit wood, and the cover is lined with the same material stitched with pandanus strands to the upper edge. The interior is lined with a plain broad weave of pandanus extending above the external rim by a foundation of two splints bound together by pandanus strips; this forms a hold for the cover. The illustration (Fig. 57) shows what is really the distinction of the whole work, the beautiful design covering the exterior. Whether this coffin-shaped basket was really intended for the use its name would imply may be doubtful; certainly in this connection it is unimportant; the remarkably effective design of the basket work is all in all. The technic is simple, a vertical series of small black strips of uncertain origin form the more conspicuous trellis, over and under which pass portions of the close band of light brown grass-like strips forming the design. Between two bands of zigzag is a much broader band of diaper work; the upper rim, which serves also as support for the cover, is a braid of black rattan strips. The design of the cover is not so successful. The vertical portion repeats the zigzag band of the basket proper, but the top is covered with a longitudinal band of diaper with two zigzag narrower bands on either side, with partings of subsidiary bands of a dark brown weave. Whatever the purpose of this basket we may be sure it was intended to hold something very precious, and I must doubt, in view of the light esteem in which infants were held in ancient times throughout the Pacific, that it was intended to hold the decaying remains of any baby, even the offspring of the highest chiefess.

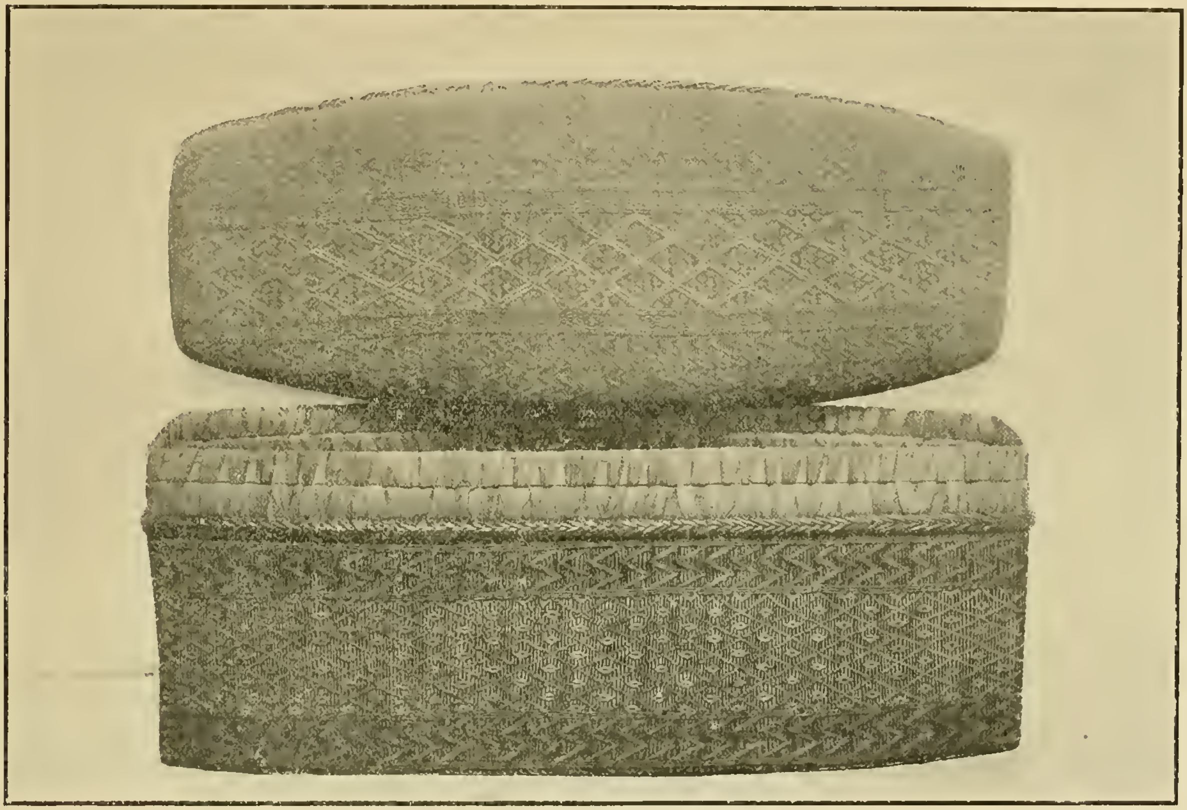


FIG. 57. FIJIAN COFFIN-SHAPED BASKET.

List of Pandanus Mats in the Bishop Museum.

2580. 7.2 ft.×4.7 ft.—16 strands to inch. Very fine and flat weave. Hawaiian.

2581. 34.3 ft.×10.5 ft. Hawaiian.

2582. 10 ft.×7.2 ft. Hawaiian.

2583. 25.7 ft.×3 ft. Dining mat. Hawaiian.

2586. 6 ft.×4.7 ft. With diagonal stripes. Hawaiian.

2591. 18.2 ft.×8 ft.—16–12 to in. Very flat weave. Hawaiian.

2598. 11.5 ft.×7 ft.—7–8. Hawaiian.

2599. 10.7 ft.×8 ft.—6. Hawaiian.

2602. 8.3 ft.×8 ft.—7. Hinano = young leaves, Puna. Hawaiian.

2603. 9 ft.×7.7 ft.—3. Hawaiian.

2780. 10 ft.×6.5 ft.—4. Checkered. Rotuma.

2781. 10.5 ft.×6.5 ft.—4. Diagonal brown stripes. Rotuma.

2782. 10.5 ft.×8.5 ft. Hawaiian.

2783. 10 ft.×9 ft.—4. Hawaiian.

2784. 11.3 ft.×8 ft. Old. Hawaiian.

2785. 10 ft.×9 ft.—7. Hawaiian.

2786. 12.2 ft.×7.5 ft.—6–7. Flat weave. Hawaiian.

2787. 6 ft.×4 ft.—5. Brown in patterns. Hawaiian.

2788. 5.5 ft.×4.7 ft.—5–6. Diagonal brown stripes. Hawaiian.

2789. 9 ft.×6.3 ft.—12. Hawaiian.

2791. 8.5 ft.×5 ft.—15. From Queen Emma collection. Hawaiian.

3239. 5.6 ft.×3.8 ft.—6. Black and white checks and twills. Niuë.

3240. 6.2 ft.×5.1 ft.—4.5. Black and red zigzags. Niuë.

3498. 9.5 ft.×5.2 ft. Leaves of two colors. Gilbert Ids.

3499. 4.8 ft.×4.2 ft. Gilbert Ids.

3500. 6 ft.×4.5 ft. Two colors with long suture. Gilbert Ids.

3501. 11.7 ft.×7 in.—9. Fringed belt, black stripe. Samoan Ids.

3505. 6 ft.×5.7 ft.—13. Fringed. Hawaiian.

3506. 8 ft.×5 ft. Hawaiian.

6310. 14.5 ft.×13.5 ft.—2. Embroidered with red. Tongareva.

6311. 8.3 ft.×6.5 ft. Strips of leaf sharply cut. Tahiti.

6629. 10 ft.×8 ft.—6. Mrs. Bishop's collection. Hawaiian.

6630. 6 ft.×3.6 ft.—6.—Mrs. Bishop's collection. Red border. Niuë.

6631. 8 ft.×7 ft.—10. Mrs. Bishop's collection. Single leaf. Hawaiian.

6632. 6.2 ft.×5.9 ft.—10. Mrs. Bishop's collection. Embroidered black and brown. Marshall Ids.

6655. 5.8 ft.×4.5 ft.—16. Irregular serrate edge, fringed leaves on ends. Samoa.

6657. 7.4 ft.×4.6 ft.—12. Double black transverse stripes. Gilbert Ids.

6659. 4 ft.×2 ft.—10. Fringe on all sides, embroidered with wool. Tonga.

6660. 5.2 ft.×4 ft.—6. Niuë.

6661. 4.5 ft.×2.6 ft.—5 strands to inch. Fringed on surface also.
6662. 5.7 ft.×1.2 ft.—14. Twilled belt, open edging on ends. Santa Cruz.
7718. 11.5 ft.×9.5 ft. Hawaiian.
7755. 2.2 ft.×1.8 ft.—4. Samples made in 1834. Hawaiian.
7962. 13 ft.×10 ft. Hawaiian.
8061. 11.1 ft.×9 ft.—5. Marshall Ids.
8444. 6.5 ft.×2.5 ft.—9. Fringed with feathers. Tonga, N. H.
8445. 10.5 ft.×22 in.—9. Fringed on long edge. Tonga, N. H.
7729. 9.8 ft.×7.5 ft. Hawaiian.

PANDANUS MATS FROM THE MARSHALL ISLANDS.

These are all embroidered around the border with hibiscus fibre, black and red-brown; the smaller sizes are used as aprons.

3215. 2.2 ft.×2.1 ft.—11 strands to inch. With hau trimmings. Maloelab, 1839.
3217. 6 ft.×6 ft.—11.
3218. 6 ft.×5.5 ft. Narrow border.
3219. 6 ft.×6 ft.—11. Remarkably wide border, mostly black.
3220. 5.5 ft.×5.5 ft.—11. Wide border, mostly black.
3221. 6 ft.×5.5 ft.—11. Narrow border.
3222. 5 ft.×6 ft.—12.
3223. 6 ft.×6 ft.
3224. 3 ft.×3 ft.—11. Wide border, mostly red-brown.
3225. 3 ft.×3 ft.—9.5. Wide border. Fig. 53.
3226. 2.7 ft.×2.7 ft.—10. Wide border. Majuro. Fig. 53.
3227. 2.7 ft.×2.7 ft.—11. Narrow border not extending to the edge. Fig. 53.
3228. 2.7 ft.×2.6 ft.—9. Wide border.
3229. 2.9 ft.×2.9 ft.
3230. 2.7 ft.×2.7 ft.
3231. 2.7 ft.×2.7 ft.—10. Narrow border, mostly black. Fig. 53.
3232. 2.7 ft.×2.5 ft.—10. Narrow border. Fig. 53.
3233. 2.5 ft.×2.5 ft.—10. Narrow border.
3234. 2.7 ft.×2.2 ft.—11.
3235. 2.2 ft.×2.2 ft.—10. Fig. 53. Only one with diagonal weave.
3236. 2 ft.×2 ft.
3237. 2 ft.×2 ft.
3238. 5.3 ft.×5.3 ft. Medium border.
6656. 6 ft.×5.9 ft.—12.
6663. 12.7 in.×7.7 in.—12. Satchel, embroidered like the mat border.
6664. 11 in.×8.7 in.—12. Satchel, embroidered like the mat border.
7563. 3 ft.×3 ft.—9. Mat with wide border.

Baskets of Ieie.—We are now to consider one of the two most distinctive Hawaiian works in basketry, and one which, for solidity and durability of workmanship, I believe to be unsurpassed in this Pacific region, nor do my limited studies in the field of basketry embrace any baskets of any region which may justly be accorded a higher rank than pertains to the baskets made from ieie by the Hawaiians. Unlike the pandanus, its near relative, the Freycinetia does not offer in its leaves its most useful product, although these are similar in shape but smaller in size than those of the pandanus. It is a slim, scandent plant, either making dense jungle with its partly recumbent stems, or climbing high among the trees where its tufts of green leaves enclosing in the flowering season the bright red flowering leaflets, among which the three flower heads rise, always attract the eye of an observant traveler. From the slender stems perpend long rootlets of almost uniform diameter which cling to the

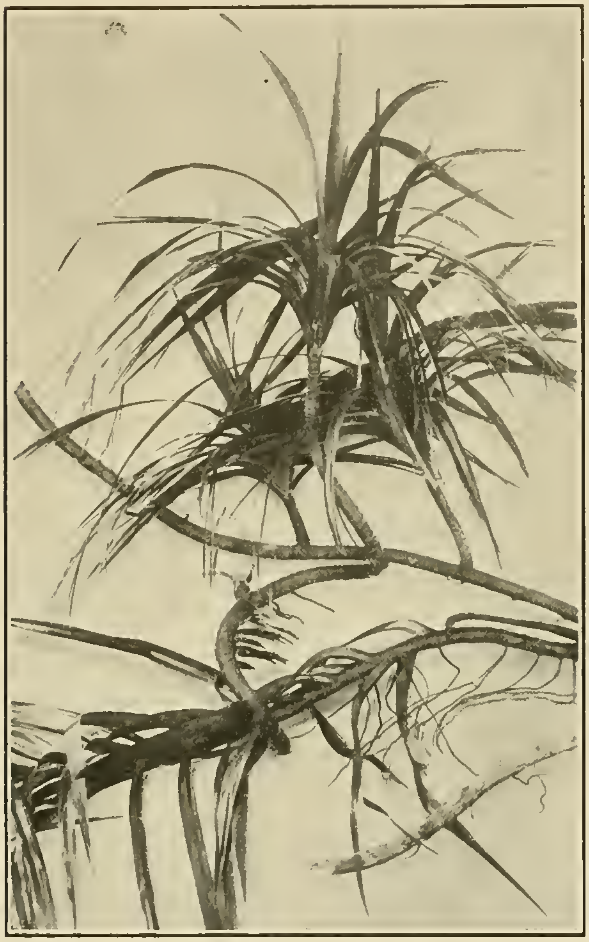


FIG. 58. FREYCINETIA LEAVES.

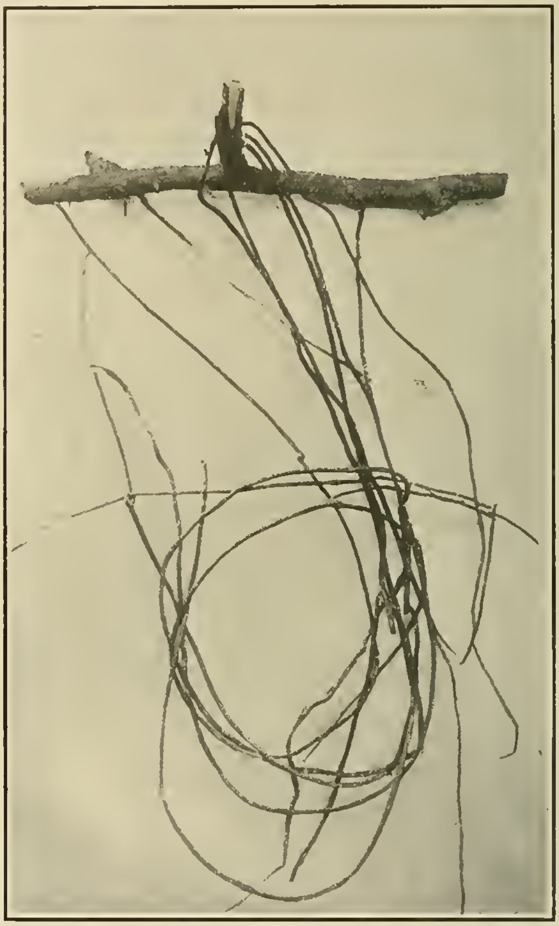


FIG. 59. FREYCINETIA ROOTLETS.

trees or swing freely in the air. Fig. 59. Slight and flimsy as these rootlets appear they are the all-important product of the plant.

> Hanau ka ieie hihi i ka nahele.
> Born is the tangled ieie in the forest.

is a common saying of the old Hawaiians, for the plant is found in abundance in the forests, especially the more elevated ones, all over the group. It is also found on other Pacific islands, the name ie, or ieie, extending through Polynesia. The Maori ikiike, or kiekie (*Freycinetia banksii*) is the same word.

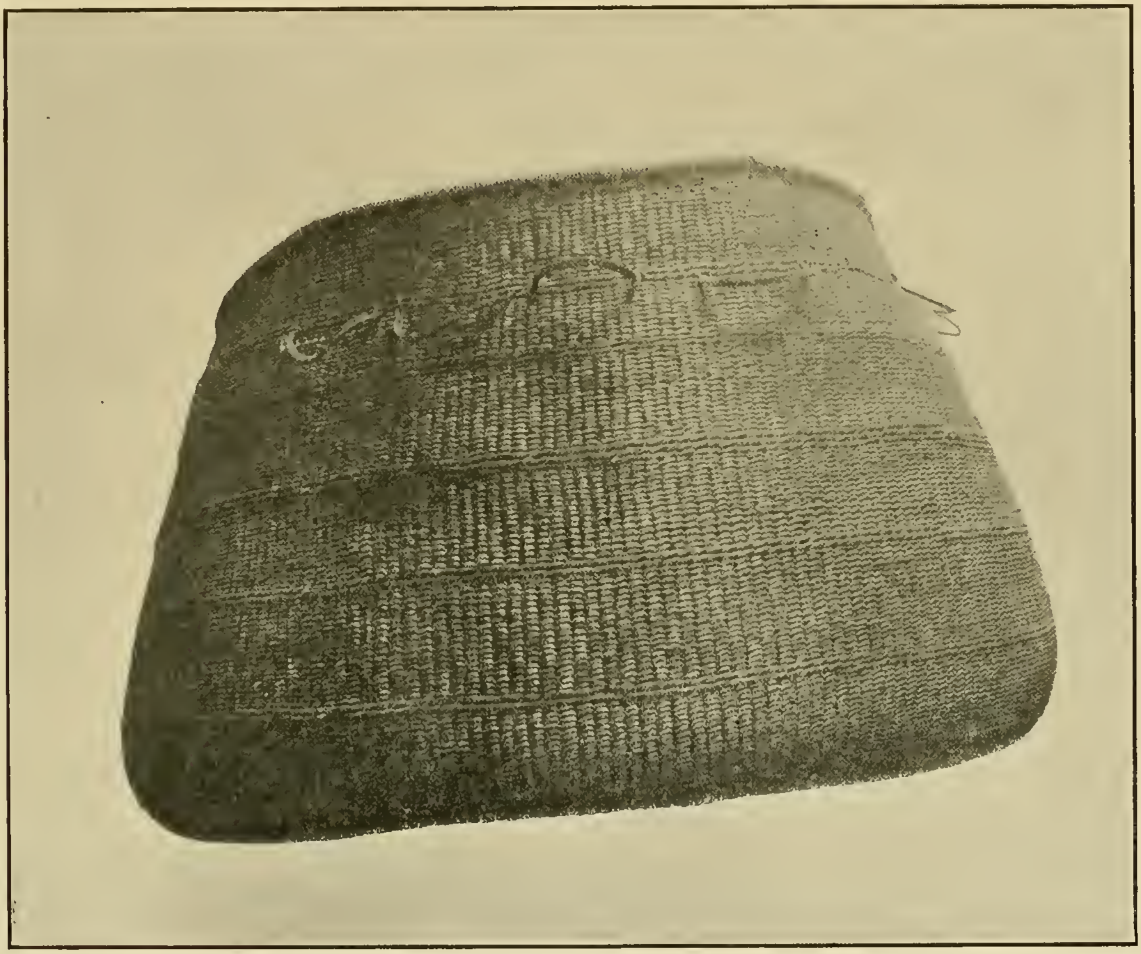


FIG. 60. BASKET OF IEIE. SEE PLATE VII FOR COVER.

In the days of idol worship the ieie was used for decorating the idols, and at the present day the word is applied to a person decorated with lei or wreaths. For general rustic decoration it is also very fit, as it does not soon fade nor drop its leaves. Ornamental it will always be, but its usefulness seems to have departed from these Hawaiian Islands, for no longer are the baskets made that attracted, alone among the basketry of the Pacific, the wonder of early visitors. There may still be a very few specimens stored in the closets of some old residents, but I know of none in any museum except the two complete with one coverless specimen in this Museum, and I shall therefore both describe and figure these most carefully.

There is little to say about the preparation of the rootlets: they were sometimes split in halves and sometimes used whole. The structure is rather peculiar and serves to distinguish this material from the many vines of the Convolvulus family that have a somewhat similar appearance. In the centre are five or six tubes which give elasticity to the strips; the ferns having in section a harder tissue of horseshoe shape.

In illustrating the finest basket of this material that the Museum possesses we find difficulty in distinguishing the two colors which were once very distinct, since age has so browned the light color of the natural stem, and so faded the deep purplish black of the contrasting portion, that while the eye with difficulty makes the distinction, the photographic plate has failed to do so, except in the middle of the second band from the bottom. Fig. 60 shows the body of the basket, and Plate VII the cover, the basket belonging to what we may for convenience call Class I. The full description is rather dull reading to any but an expert in basketry, but is worth giving, there are so few specimens left, and time must destroy these.

No. 7651. Diameter 26 in., height 17 in. Specimen in good condition, except that the cover is cracked all along the upper rim, and several of the side cover loops are gone. Starting from the rim, which is of course reversing the order of manufacture, this rim is flat, consisting of two rods carefully clothed with flat strip, every fifth and sixth one going down under two horizontal twisted rounds in which the strips pass over two of the upright strips. Then a band of dark and light strips, originally light brown and black, 16 rounds of two-ply over uprights of 3 rods each; 2 rounds twisted, followed by 12 plain brown; 2 twist, variegated band of 17 rounds; 2 black twists and 1 brown, 16 brown and 2 twists; sides then turn in to form bottom with a variegated band of 16 rounds, 1 brown, 1 black and 1 brown twist; 11 variegated rounds, 7 brown rounds, 3 brown twists; 15 brown rounds, 2 twists; 10 brown rounds followed by 7 twists to centre of start. There are 19 braided sennit loops to attach cover. Cover is formed with the same kind of rim, 2 twists, 2 black, 7 brown rounds, 1 twist; 19 variegated, 2 twist, turning edge; 18 brown rounds, 2 twist; 25 variegated rounds, 12 twists; 8 brown and 2 black twists; 12 twists to centre. This basket, supposed to have come from the island of Hawaii, was many years in the cabinet of the A. B. C. F. Missions in Boston.

No. 6589. This basket is plain brown without color decoration, 17 in. in diameter and 10 in. high. The rim is similar to the last, but has three bars as a foundation instead of two. The succession from the rim is as follows: 2 twists, 10 rounds;

2 twists, 19 rounds; 2 twists, 17 rounds; 2 twists, 17 rounds on the bilge; 2 twists, 18 rounds; 2 twists, 12 rounds; 7 twists to centre. The cover rim has one rod and the binding strip attaches it to the two succeeding twists, by the sixth and seventh round some go over both twists, others over only one. Then come 12 rounds, 2 twists on the edge of cover; 12 rounds, 2 twists; 14 rounds, 2 twists; 11 rounds, 2 twists; 6 rounds, 4 twists to centre. The label which came with this specimen reads as follows: "This was originally the property of Mrs. Coan, of Hilo, Hawaii, but it has been in use in the family of Mrs. S. N. Castle, of Honolulu, for over fifty-five years, and is given by her to Mr. Brigham for the Bishop Museum."

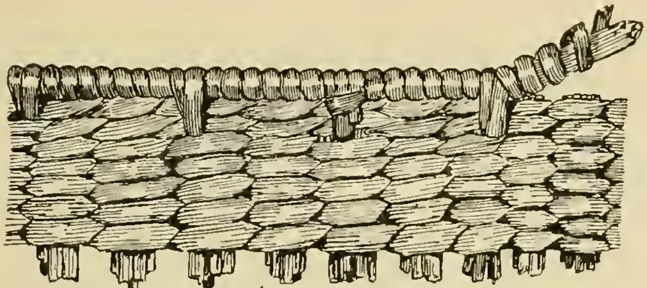


FIG. 61. EDGE OF BASKET NO. 6589.

No. 6942. Diameter at bilge 18 in., at rim 12 in., height (without cover) 9.5 in. The rim is composed of five small rods bound and attached in a way similar to those in the two preceeding specimens, but with less regularity. The sequence is 2 twists, 10 rounds; 2 twists, 20 rounds; 2 twists, 15 rounds; 2 twists, 15 rounds on the bilge; 2 twists, 13 rounds; 2 twists, 15 rounds; 3 twists, 11 rounds; 8 twists to centre; no cover extant. The outside has been painted all over a lead color, but the inside is fresh and unstained. Specimen from the curious old stone house at Kailua, Hawaii, built by Reverend Asa Thurston (arrived 1820), and was used by the Thurston family there and elsewhere for seventy-five years.

These three are the only surviving specimens belonging to this class of ieie baskets that are known to the writer. The length of time these have been in use is remarkable, and shows the great strength and durability of the material. The three are of the same general pattern, and might have been made by the same hand; the perfection of the work seems to show that there must have been many made before such skill could have been acquired.

The next class comprises the fine baskets woven over wooden umeke or gourd calabashes or bottles, and several very fine specimens are in the Bishop Museum. Exactly how these were made I cannot say, and the technic must be gathered from the specimens, for in the early days of my explorations on this group I never saw any such baskets, and have not been able to learn much about them from the present generation of natives. It seems to have been the only basket figured and noticed by the early explorers, and Freycinet makes a curious mistake in the material used. It seems worth while to quote his account:

"On fait avec la feuille du ti, quelques ouvrages dans le goût de ceux de nos vanniers, mais peut-être mieux finis; les uns sont d'une seule teinte; les autres, tels que les casques, les éventails, les panniers, le clissage des calebasses où l'on serre les effets precieux, &c., sont nuancés de couleurs diverses. Ces ouvrages, confiés aussi à la main délicate des femmes, offrent des formes et dimensions très-variées.[17]

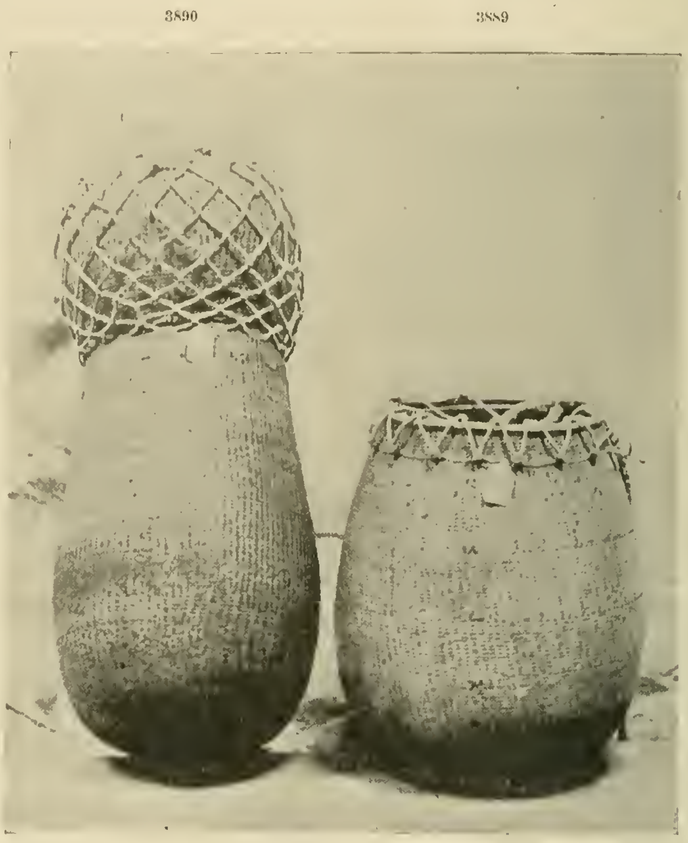


FIG. 62. HINAI POEPOE.

What the French Commander took for the leaves of the ti (ki, *Cordyline terminalis*) was afterward named for him *Freycinetia*, and the figures given in Freycinet's report leave no doubt that the baskets we are now considering were the ones referred to in the quotation. As he says, these hinai poepoe were used as receptacles for their greatest treasures, and we know that when the breakage of the interior umeke or calabash deprives these baskets of their waterproof character and they fall to baser uses they will still serve for many years as fish baskets, or for other purposes. Demijons and carboys, hard receptacles covered with basket work by more civilized people, are only fit for destruction when the inner part is damaged! Figs. 62, 65 and Plate IX give fair representations of the best of these hinai poepoe, and the following list of those in the Museum will explain the illustrations:

No. 3890 (Plate IX) measures, as figured, 21.5 in. high with cover; greatest diameter 9.2 in. The inside wooden (kou) umeke measures 13.2 in. in depth (internal), and 5.7 in. at the mouth. The cover is of the same material and has 6 in. and 6.7 in. internal measurement. The outer basketry comes to within three-quarters of an inch of the top of the umeke, and is finished off by a braid which does not project beyond the general surface; a net of oloná is attached below the fourth round. The cover has a rim like the baskets of the first class, but smaller, and in both the weaving is close and varied only by reversing.

---

[17] Freycinet, Voyage autour du monde, 1817-20, II, p. 613.

No. 1405 (Fig. 65) measures 28 in. high and 13.5 in. at the greatest diameter. The interior is a gourd 23 in. deep and 5.2 in. at neck. The strands are three-ply in cover of which the gourd is lost.

No. 3889 (Pl. IX) has a wooden umeke as well shown in Fig. 63; there is no cover; height 12.5 in., while the umeke measures inside 10.5 in., with a diameter of 6.5 in. at neck. The beautiful and close weave at the neck is shown in the figure.

No. 1403 (Pl. IX) is 25 in. high and 16 in. in diameter: cover empty: both baskets neatly finished at ends by braid.

No. 1406 has no cover; is 14.5 in. high, 13.5 in. in diameter, and contains a gourd; closely woven around the rim.

No. 1550 (Fig. 65) is remarkably long and originally covered a wooden umeke which was broken many years ago, and for more than a score of years the basket has been used as a receptacle for fish. It is 36 in. long,—the longest known. The base shows an unusual beginning for these baskets (Fig. 64). The variations in the bands are shown in Pl. VI and, in part, in Fig. 65.

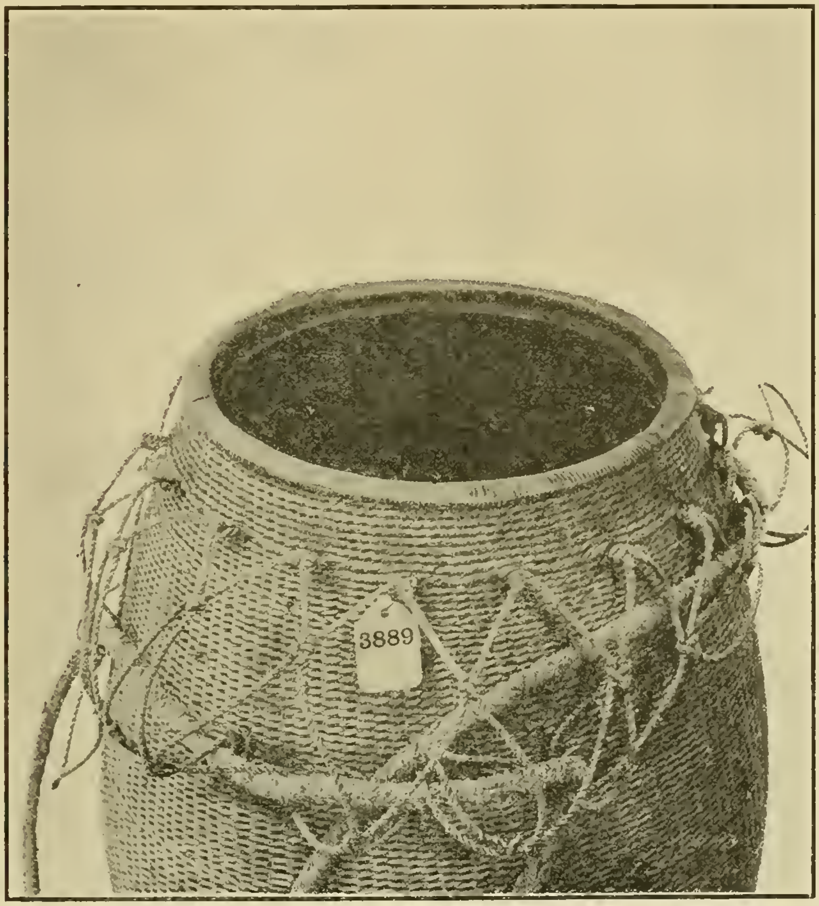


FIG. 63. MOUTH OF HINAI POEPOE NO. 3889.

No. 3890 (Pl. IX) is woven around wooden umeke, in body and cover; height 22 in., diameter 9 in. Best in collection.

No. 1409 (Pl. VIII) is one of the flat calabash baskets, 12 in. high and 18 in. in diameter. As this is the only one of this flat form and has no cover, it is difficult to say what that part consisted of, but it was probably a flat basket work disk, and the basket was used for the preservation of some choice feather cape or lei.

No. 7705 has a diameter of 16 in. and is 27.5 in. high. It is woven on a gourd, but the cover is now empty and the whole is contained in a koko or net used for such purposes.

No. 3844 has lost its internal umeke or gourd. The weaving is much like that in Class I, within which it would be included but for its shape. Height 24 in., diameter 14 in. It has heavy cord loops to secure the cover.

No. 1404 has a height of 16.5 in., and a diameter of 9.5 in.; gourds in basket and in cover; the general finish very good, the weave being in a continuous spiral from beginning to the rim. There are six black bands on the basket and five on the cover; the net for the cover is of oloná (Pl. IX).

In all this class of baskets the work is far above the average of Hawaiian, or indeed Pacific, basket making; the weave is exceedingly close and regular, and the form is peculiar to this group, but most closely resembling certain Hawaiian containers made for holding fish lines, but of wood and gourd without any basketry.

We now come to another class where the workmanship is far inferior, although the general form still reminds us of the fine hinai poepoe. The material, ieie, is the same, but the strips are either used unsplit or carelessly combined. In some an attempt to imitate the older and better work seems present; in others the product is a coarser basket without any enclosed container. The basket becomes suitable for holding fish or any coarse or dirty objects without having to wait until the inner gourd or umeke is broken. The list is not a long one.

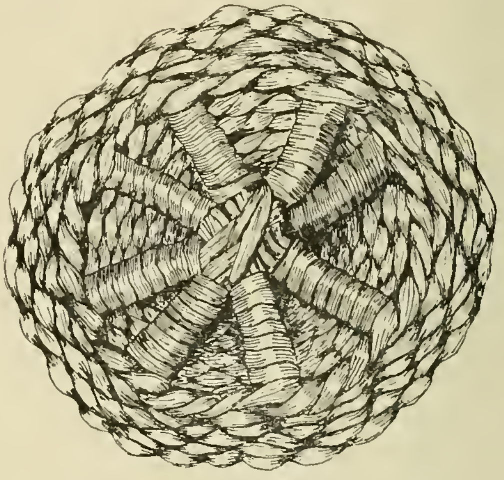
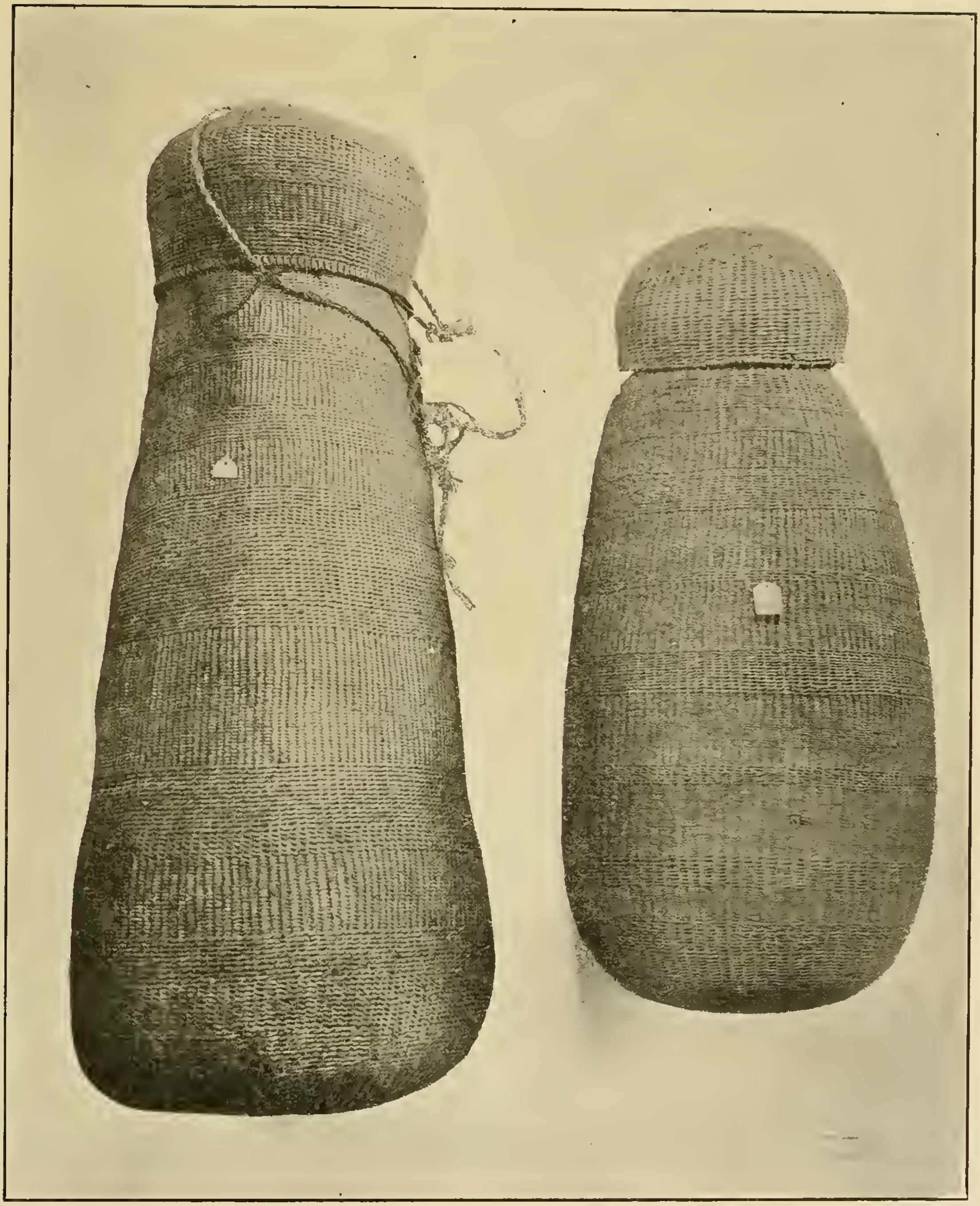


FIG. 64. BOTTOM OF BASKET NO. 1550.

No. 1407 is a very modern attempt to imitate the fine work of the old Hawaiians, and, apparently has never been used. Two gourds are employed for foundation, and the basketry is of the coarsest two-ply weave over single rods of the same material; it has much the same appearance as the common demijohn wicker work. Height, with cover, 19 in., diameter 13 in.; net of coco fibre cord. The ieie strips have not been halved; they have only a small portion removed, and the strip is of course less pliable.

No. 4050 is a modern basket finished much as the last, but independent of gourd or umeke, and with a flat top. Height, with cover, 12 in., diameter 10.5 in. Fig. 66.

No. 1408 is of the same general form as the preceding, but is of greater age. It has apparently been woven without any interior vessel, and with Nos. 4050 and 3845 might be put in Class III for convenience of classification. The workmanship is by no means so fine as in Class I, but is better than in No. 4050. Height, without cover, 13 in., diameter 11 in. The rims of both basket and cover are made exactly like that figured in No. 6589, and the latter is secured by a single coco fibre cord ex-



1550 FIG. 65. HAWAIIAN HINAI POEPOE. 1405

tending from its centre to the encircling net of the basket, this net being made partly of oloná, partly of coco fibre. Central specimen in Fig. 66.

No. 3845 is like the last specimen, as may be seen in Fig. 66, but is much smaller, and in place of the usual net to fasten the cover in place, has two loops of cord knotted through the sides, which serve also for handles.

No. 3887 has no cover and was made as an independent basket; the rim is neatly braided and the rounds are three-ply. The rods, added as the diameter increases, are not always spliced to those already in place, but are interpolated like a V, making two rods for each insertion. Height 17 in., diameter 14 in. Has been mended in places with a "darn" of coco fibre cord.

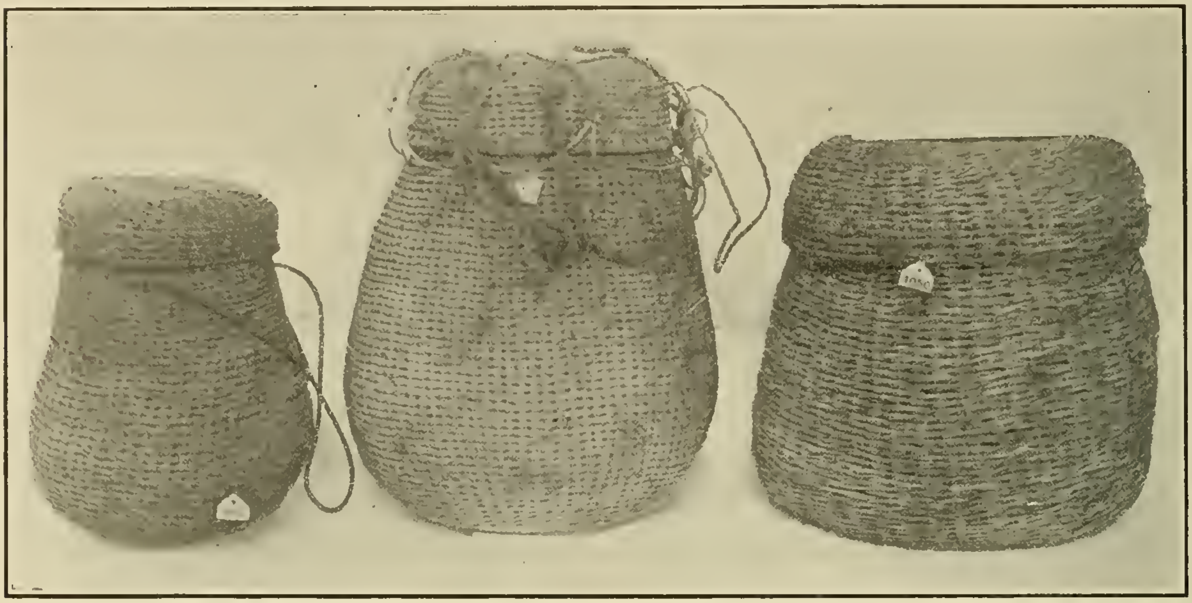


FIG. 66. GROUP OF FLAT-TOPPED HAWAIIAN BASKETS.

No. 3843 is similar to the last, but of coarser workmanship; the rounds are still three-ply, and the rims both of basket and cover are of a number of strips intertwined around the bent ends of the rods, as shown in Fig. 67. Height 17 in., diameter 12 in.

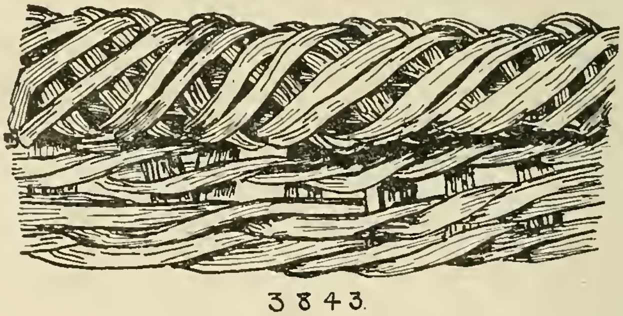


FIG. 67. RIM OF BASKET NO. 3843.

Not only umeke and corresponding gourds were covered with basketry by the old Hawaiians, but also the huewai or gourd water bottles, probably in all cases for additional strength; but with the huewai it also helped to keep the contents cooler. When I first saw the following specimen I was inclined to think the natives in modern times had copied the wicker-covered glass bottles used as perfume bottles or pocket flasks by the foreigners, but I am assured by old Hawaiians that their people made such water bottles in ancient times.

No. 5350 is a huewai or water bottle of gourd covered with a closely-woven three-ply spiral band, alternately brown and black. There are two braided ears on opposite sides of the spring of the neck, to which are still attached the remains of a square braid cord; the cap or capsule is of the same work.

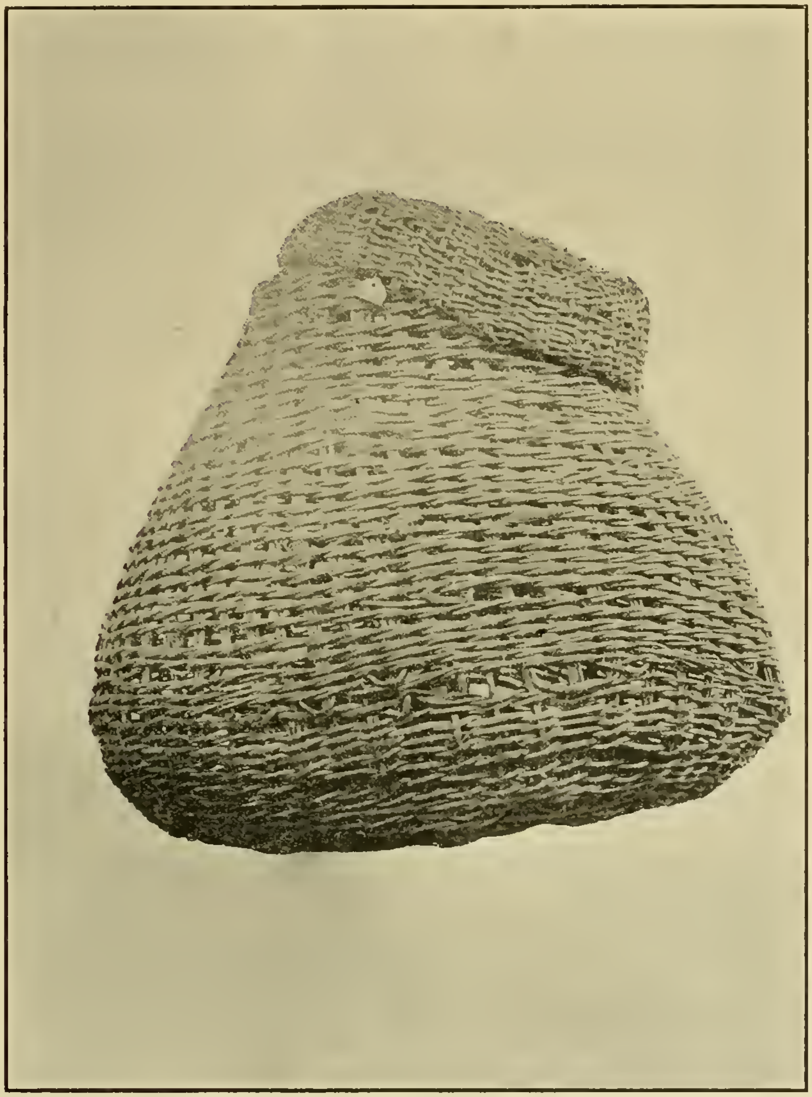


FIG. 68. HAWAIIAN FISH BASKET, NO. 3842.

We come now to an entirely different kind of basket, both in shape and in purpose, although there is, it is true, some likeness in shape to the beautiful baskets of Class I. Its shape and weave is sufficiently shown in the figures to dispense with any particular description. A people depending, as did the Hawaiians, on fish for food would naturally have developed their basketry in that line, and we shall briefly touch upon the common forms, leaving a fuller description of their actual use for the chapter on Hawaiian Fisheries. Many of the baskets that have been described have been used for fish when no longer fit for their original purpose, but the specimen here figured was made for fish and not for anything else.

No. 3842 is a fish basket with a height of 17 in., with cover, and a diameter of 19 in. The weave is three-ply on the basket, and two-ply on the cover, and there are no handles nor fastenings for the cover. See Figs. 68 and 69.

These baskets were common and seem better suited to their purpose than those of woven pandanus leaves already described, and they are both stronger and more durable, but, perhaps on account of their use, they are not often found in collections, as the old ones become very dirty and fishy. Hawaiian fish traps were sometimes made of ieie, sometimes of other vines, but genearlly of iwaiwa or fern stem, and have been described under that division. The curious shrimp baskets deserve notice here, and Plate IV may be consulted for their general appearance and construction. As that plate shows, they vary considerably in size, and in recent times the vendors of curiosities have introduced immense ones to serve for hall decorations or umbrella holders. The scale on the plate is sufficient guide to the size of those figured. Nos. 7681 and 7682 are of a more common size. It should be added that these baskets are used to catch the shrimps, and not to store them.

Idols and Helmets.—Another extensive use of ieie strips and rods is found in the manufacture of images of the gods, and helmets. Of the former, huge simulacra were constructed, none of which are now known to exist, although in the early days of the American Mission (1820–1835) sone large specimens remained at Kailua, Hawaii, and it is quite possible others were concealed in caves which may

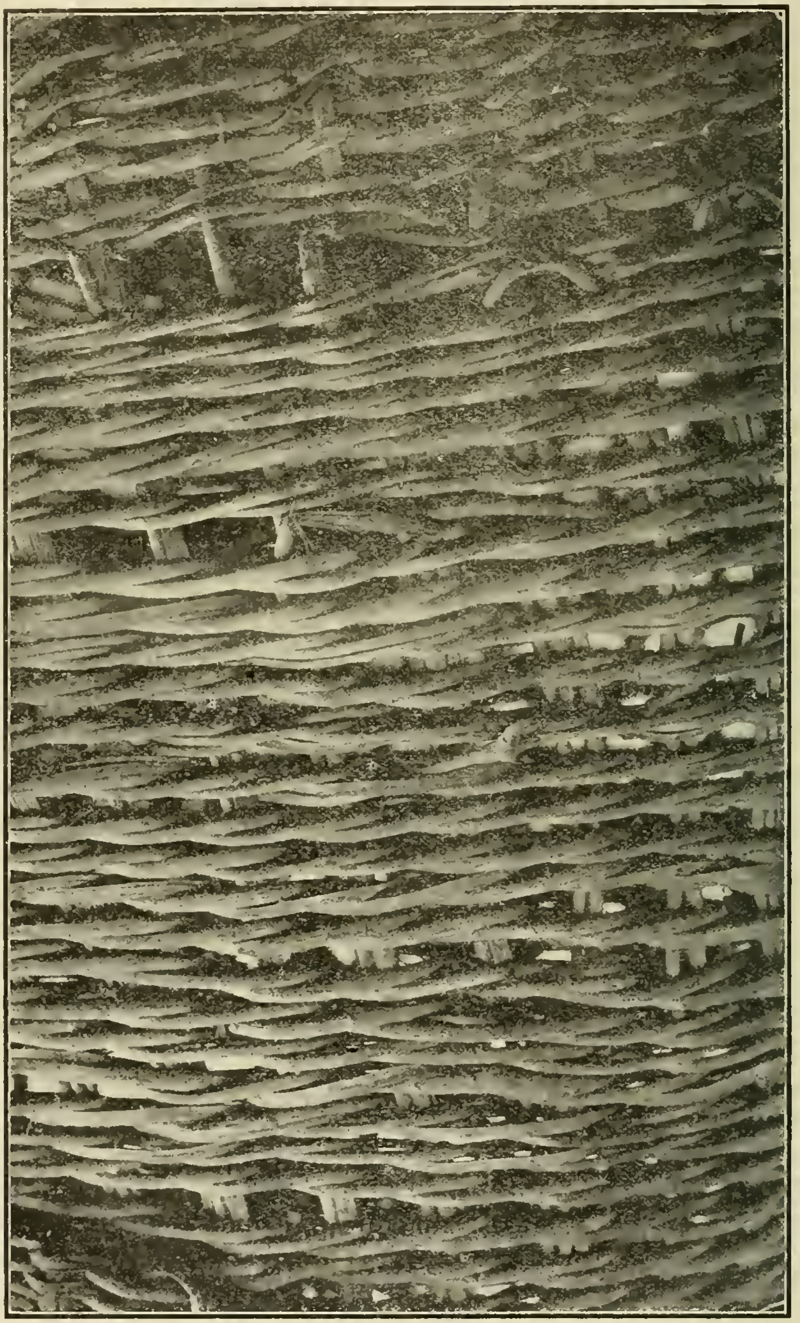


FIG. 69. ENLARGED PORTION OF NO. 3842.

still preserve them. The late King Kalakaua described to me such images he claimed to have seen in a cave in the cliff above Kealakekua Bay. There are still in existence, however, a number of smaller images, notably those of the war god Kukailimoku, some of which have been figured and described in the first volume of these Memoirs. These consisted of a head and neck of ieie basket work, often very neatly made, which was covered with a closely fitting net of oloná fibre, to which were attached the red, yellow and black feathers which distinguished the god.

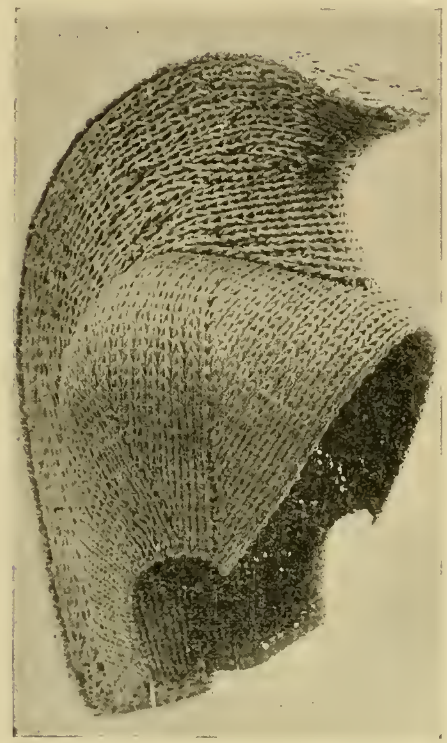


FIG. 70. WICKER WORK HELMET.

The helmets of the ancient chiefs are even more widely distributed through the principal museums of Europe and America. Some of these are made in a comparatively rough manner, as the wicker work was to be covered with feathers, while others were finished specimens of basket work. Illustrations of both classes have been given in the Memoir on Ancient Hawaiian Feather Work,[18] and Figs. 70 and 71 may here repeat examples of them for convenience. The first, Fig. 70, which is in the Australian Museum, Sydney, N. S. W., was once covered with feathers, and is made firmly of a braided structure ingeniously adapted to the irregular shape of the helmet. The other, Fig. 71, was beautifully woven in the manner of the best baskets and was worn without the feathery decoration. Others, apparently intended to remain featherless, are in Berlin, London, Paris and Cambridge, Mass. I have not examined all the substructures of the feather helmets figured (*loc. cit.*), but as all in this Museum are of the same material I infer that it was generally used for these images and helmets.

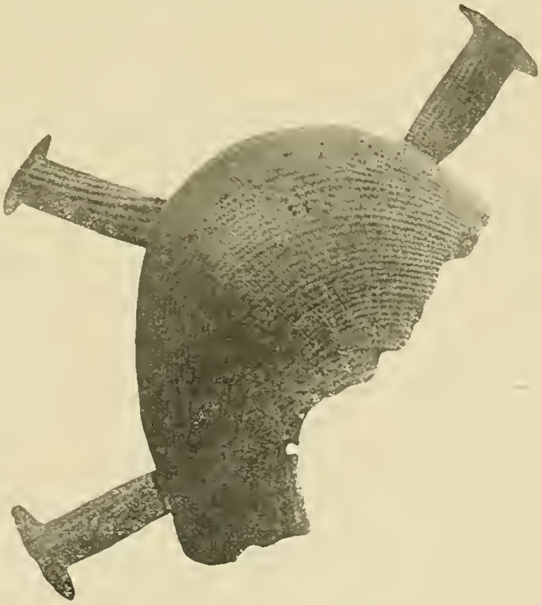


FIG. 71. HELMET OF IEIE.

Fern Stems.—Although among the Hawaiians fern stems were not in common use, they served for small and ornamental

[18] Memoirs B. P. Bishop Museum, Vol. I. No. 1.

baskets, as at the present day. Three ferns bore the general name *iwaiwa*,[19] *Asplenium Adiantum-nigrum*, *Pteris decipiens* and *Adiantum capillus Veneris;* all of these having smooth dark-colored stipes varying in color from dark brown through purple to black. A material not very flexible (except when soaked), but glossy and durable.

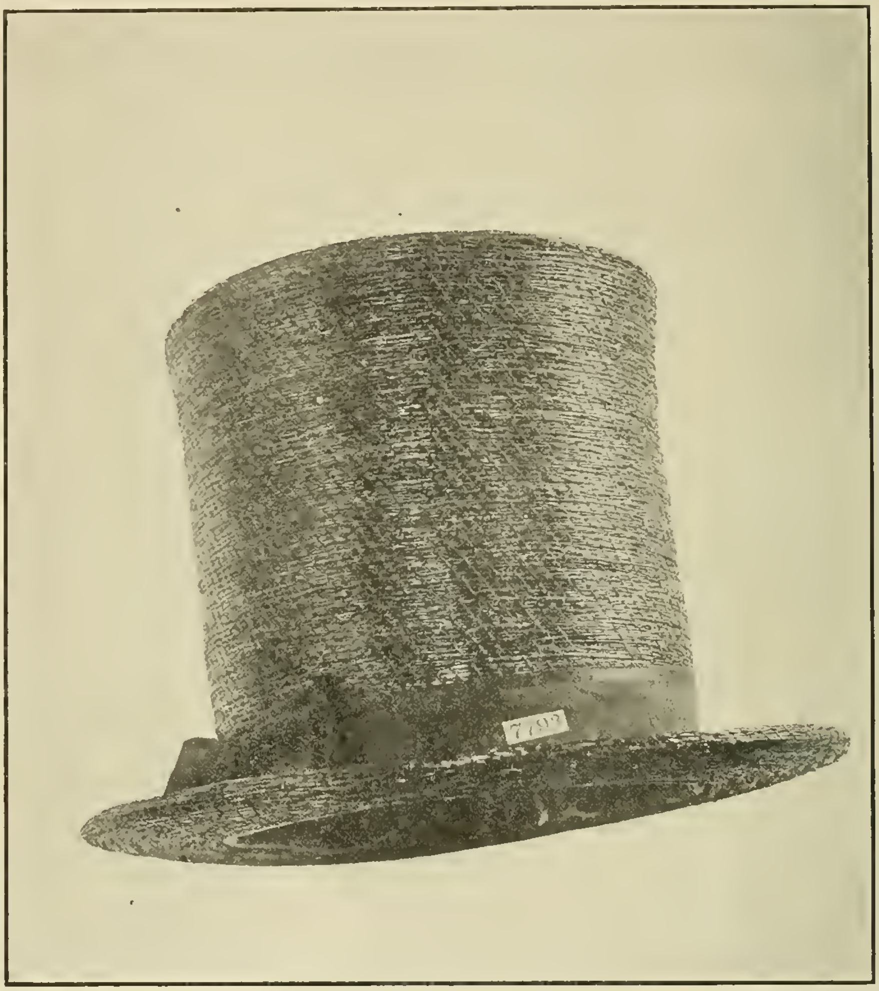


FIG. 72. HAWAIIAN FERN-STEM HAT.

In the days when Honolulu was a rendezvous for whalers in the Pacific a fashion was introduced among the Hawaiians that must have borrowed from methods used long before, so that in describing it the mere curiosity of the result yields wholly to the suggestion of a manufacture of fern-stem basketry, of which no other remains are extant. The hats for women, still made in fancy form, do not suggest any ancient origin. Captains of whalers almost invariably had on board their vessels at least one silk hat, not always of the latest block, which they were accustomed to wear ashore on public or important occasions, and these absurd and uncomfortable head-dresses, which fashion imposed upon the white man, roused great admiration in the breast of his dusky imitator. Wives or sweethearts soon fashioned the respectable imitation (it was in the days of the early missionaries), which is shown in Fig. 72. Fern stems and horse hair are the components, and it was certainly better fitted to withstand tropical rains than its silken prototype. The particular specimen figured, now in the Bishop Museum, was given to the Rev. Rufus Anderson, D.D., Secretary of the American Board of Commissioners for Foreign Missions at the time of his visit to these Islands in 1863. About the same time I saw in the streets of Honolulu a powerfully built native clad only in such a hat and his scanty malo. To the present day the Hawaiians show a respect for this form of hat, although now selecting the imported variety. The specimen illustrated weighs 10.5 ounces.

---

[19] Andrews gives the definition "He mea ulu e like me ke palaa, ua ulana pa ia me ka papale mauu."

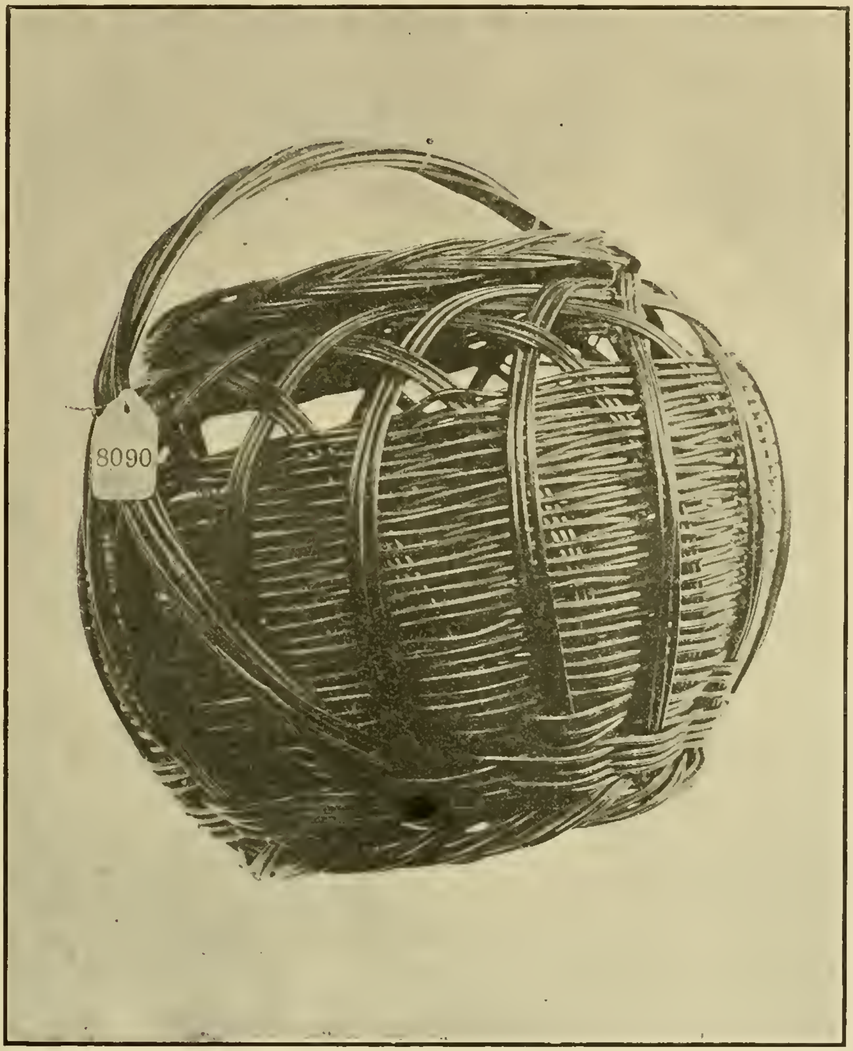


FIG. 73. MODERN JAPANESE FERN-STEM BASKET.

In the Museum collection is No. 8090, shown in Fig. 73, a graceful modern basket made for sale rather than for use. It is Japanese, but was brought by two old natives, known to me for many years as dealers in mats and baskets, with the assurance that it was made by Hawaiians. On their statement the figure was inserted and remains as a warning to collectors of basketry.

On the other groups to the southward more use was made of fern stems, especially for fish traps and baskets, as they are not readily rotted in water. In New Zealand are made fine eel traps (*Hinaki*) and baskets in which to keep fish alive (*Whakarapa*), both shown in Fig. 74. These are made of *mengemenge* fern (*Lygodium articulatum*) a twining fern with stems of great length. The genus is found as far away as New England. The stipe of the *Heruheru* fern (*Todea* (*Leptopteris*) *superba*) is said[20] to be used in the manufacture of combs,

[20] A. Hamilton, Maori Art, p. 302.

Heru, but the stipita of this splendid fern are very short, seldom exceeding three inches in length, and, however fit for the teeth of combs, not suited for weaving baskets.

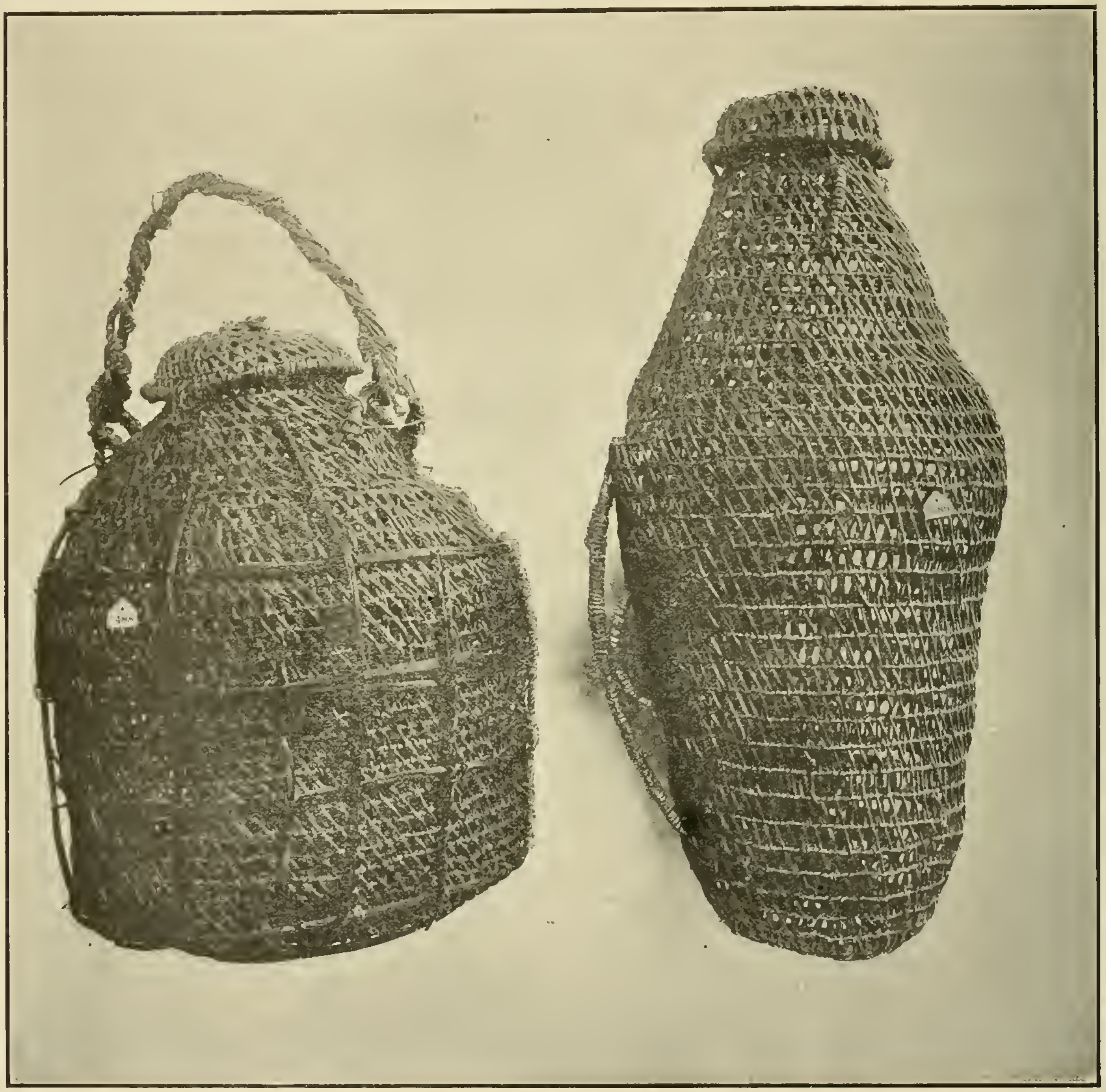


FIG. 74. WHAKARAPA AND HINAKI, NEW ZEALAND FISH BASKETS.

The illustration shows that as specimens of basketry both the Hinaki (compare Hawaiian *Hinai* basket) and Whakarapa are well and strongly made. The handle of the latter is of a form unusual in this region and resembles the bail of a pail. In the Hinaki one long handle extends nearly the length of one side, strengthened in the middle; while two smaller ones are at the lesser end and 90° from the main handle; the cover is hinged and has a loop to fasten it, and the entrance for the eels is at the larger end.

No. 6954 is a very large fish trap made of the same material, measuring 48 in. in length, and 24 in. in diameter. It has three loops on each side near the smaller end. When wet it may be folded flat, although very stiff and firm when dry. The exquisite braid work of the Solomon Islanders has generally been described as of fern, and has even been attributed to a species of *Gleichenia*, but we have in the Museum specimens of a grass from which this attractive work is made, so we must defer farther notice of this to succeeding pages, where the grass manufactures take their turn.

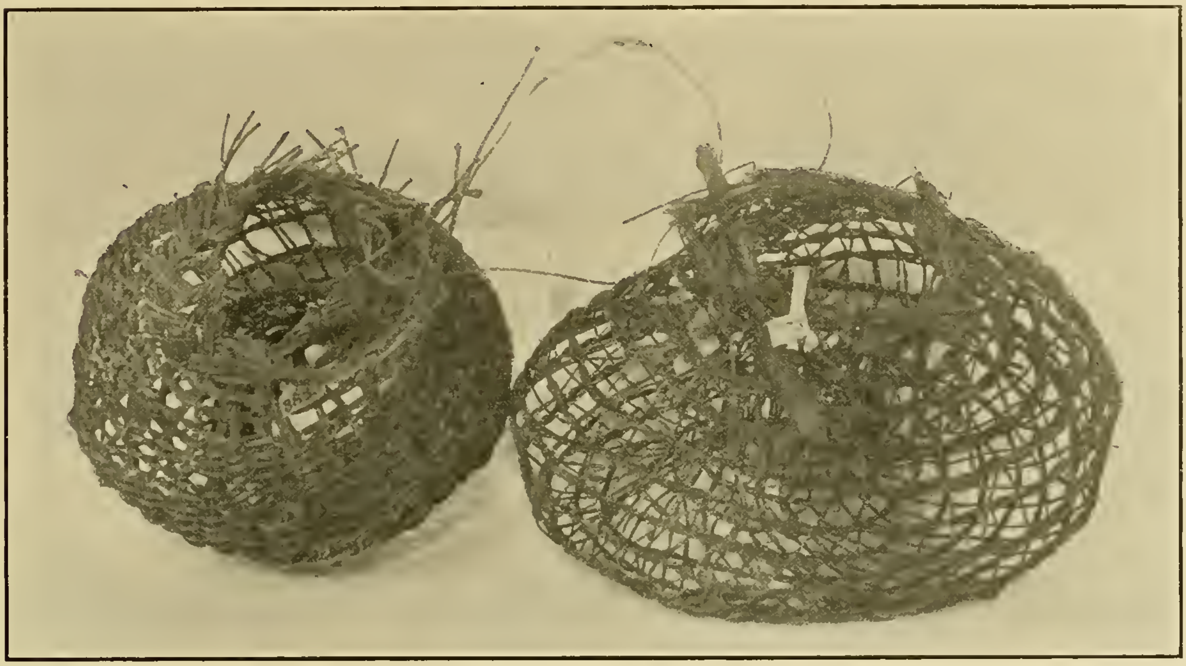


FIG. 75. HAWAIIAN FERN-STEM FISH TRAPS.

So far as is known the old Hawaiians made nothing of fern stems of such great size as the Maori hinaki; indeed they had no fern stems to compare with the *Lygodium* of New Zealand, but they made similar traps of the much shorter Hawaiian ferns. Two of these are shown in the figure, and I am informed that such traps were much used in ancient times; and while sometimes made of other material, as at the present day, the fern was much preferred, and considered more durable. It is quite possible that the dark color of the fern gives some advantage to the fisherman.

Hawaiian Sandals=Na Kamaa Maole.—Necessity must, in very primitive times, have given birth to the invention of sandals in a country where volcanoes often spread lava streams of most extreme roughness across the paths until for miles a surface is formed that not even the hoofs of a horse can stand. Few who have not dissected the foot of a man accustomed to go barefoot can have any idea of the exceeding toughness of such a man's sole; but as little can one who has not walked over it appreciate the sharp roughness of a stream of Hawaiian *aa*, the roughest form of lava. The toughest soled native needs some artificial protection for his feet. In climbing Mauna Loa, the largest of the Hawaiian volcanic mountains, in 1864, the author wore out three sets of rawhide sandals used as protection to stout walking shoes, and only occasional beds of aa were encountered. No one could travel around the island of Hawaii, near the coast, without meeting many miles of this rough road. Where a permanent path was needed smooth beach pebbles were laid for footway, but on occasional journeys one often found no such provision for his feet, and he was forced to weave or braid some mat-like structure for sandals. Any tough fibre at hand was pressed into service; pandanus (*lauhala*), dracæna (*la'i ki*), hau bark (*ili hau*), banana (*lau maia*), poaaha or waoke, all answered sufficiently for the temporary need.

Plate III shows examples of all these. In structure there were two general ways of plaiting the hastily constructed basketry: one, the simplest, consisted of a stout cord of any suitable material formed into a loop for the toes and over and between the parallel sides formed by the cords the leaves were braided or entwined, the tougher stems being left for the under surface, as shown in the first example on Plate III. The loose ends of the looped cord served to bind the sandals to the ankle. The third specimen shown in the same plate is a little more complicated, there being four instead of two cords about which the weft is twined. Fig. 76 shows this more clearly, the loops work in opposite directions and when pulled draw the substance of the sandal together. When waoke or maia was used a very comfortable and serviceable foot support resulted: such are used even now by the white man as well as by the Hawaiian when walking much on the rough coral reefs.

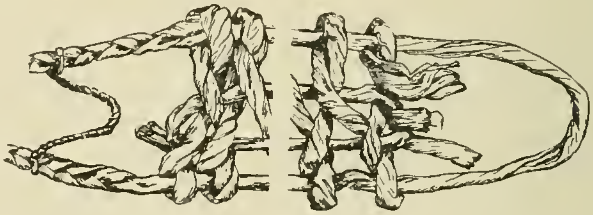


FIG. 76. PLAN OF SANDAL.

Of the sandals in the Bishop Museum at this writing the following list will fairly show the comparative frequency of the material used:

4535. Sandals of lauhala, dry but without special preparation.
4537. Sandals of lauhala.
4538. Sandals of poaaha or partly beaten waoke, rectangular in shape.
4539. Sandals of poaaha, thick and tough.
4540. Sandals of banana leaf stem. These are always rectangular.
4541. Sandals of banana leaf stem with ili hau cords.
4542. Sandals of malina (American aloe).
4543. Sandals of hau bark = ili hau (*Paritium tiliaceum*).

4544. Sandals of lai ki (*Cordyline terminalis*).
4545. Sandals of lai ki for a child.
4546. Sandals of lai ki, stout and coarse.
4547. Sandals of lai ki, well braided.
4548. Sandals of lai ki, from the Queen Emma collection.
4549. Sandals of malina or aloe.
5107. Sandals of poaaha or partly beaten waoke (*Broussonetia papyrifera*).
8986. Sandals of lai ki.
8987. Sandals of lai ki.
8988. Sandals of lai ki.
8989. Sandals of lai ki.
8990. Sandals of hau bark = ili hau.

No other covering for the feet than these sandals were known to the Hawaiians before the advent of foreigners. Although they had the pig I do not know that they ever used pigskin for making sandals, not even after they had seen the pigskin-soled grass slippers of the Chinese, who were early immigrants, Vancouver finding, only fourteen years after the death of Cook, many of these orientals in the country.

Niihau or Makaloa Mats.—In describing the Hawaiian baskets of ieie mention was made of another notable manufacture of these islands, one which is now fast passing to the region of lost arts where the ieie baskets have gone. A few old women still make the mats from the sedge which grows commonly enough along shores and in brackish marshes. It was chiefly on the little island of Niihau that the makaloa mats were made, although the sedge (*Cyperus lævigatus*) grows on Oahu and other islands of the group, and it is claimed that those with colored figures (*Na moena pawehe*) were not made elsewhere. Exact information is hard to obtain on such matters, but certainly Niihau, populous enough in olden time, was the chief factory and gave name to the fabric. This was doubtless the mat noticed with admiration by early voyagers, of which mention has been already made.

The preparation of the sedge was simple, but only while the plant was young could the finest mats be woven, so that the time of working on these was limited to a few months each year, and the people had not learned the method of procuring a succession of crops. The weaving of the mat was begun, as shown clearly in Plate X, and the leaves added as needed. In comparing this figure with that of the pandanus mat, Fig. 54, the great difference in the length of the staple will be noted. As with the hala, the leaves dried over a fire were whiter, and in the case of the makaloa these were called *olala;* it was the favorite kind of leaf used, except perhaps for the large floor coverings. The red figures are formed from the lower portion of the stem, which is naturally colored; but while this color is fairly durable, it turns a dirty brown on long exposure to the light. The fresh color, both of the olala and the red figures, is well shown on Plate XVI. These figures are an embroidery and do not show on the reverse. The patterns used are very simple geometric ones that do not present the variety shown in the decorated Hawaiian kapa, but the nature of the texture kept these within narrow bounds. Even on kapa, where the surface admits of any form, we seldom find the attempt to represent natural objects; almost always it was ornamentation composed of triangles, rhombs, squares and lines. All these patterns had names, and I have been at some pains to preserve these which will be found in the illustrations (Figs. 77-81, and Pls. XI–XIII, and XVI). Not only did the weaver use these external decorations, but in the very weave she used her fancy in a way seldom found in the hala mats, and some mats are a series of stripes, each of a different weave. These fancy stripes sometimes alternate with those of a plain weave, and on these latter were generally embroidered the red figures. One mat in this collection, No. 10,072, recently made, shows not only nearly all the usual figures but is woven in nearly all the known styles, including fancy twills. The names of the patterns are as follows:

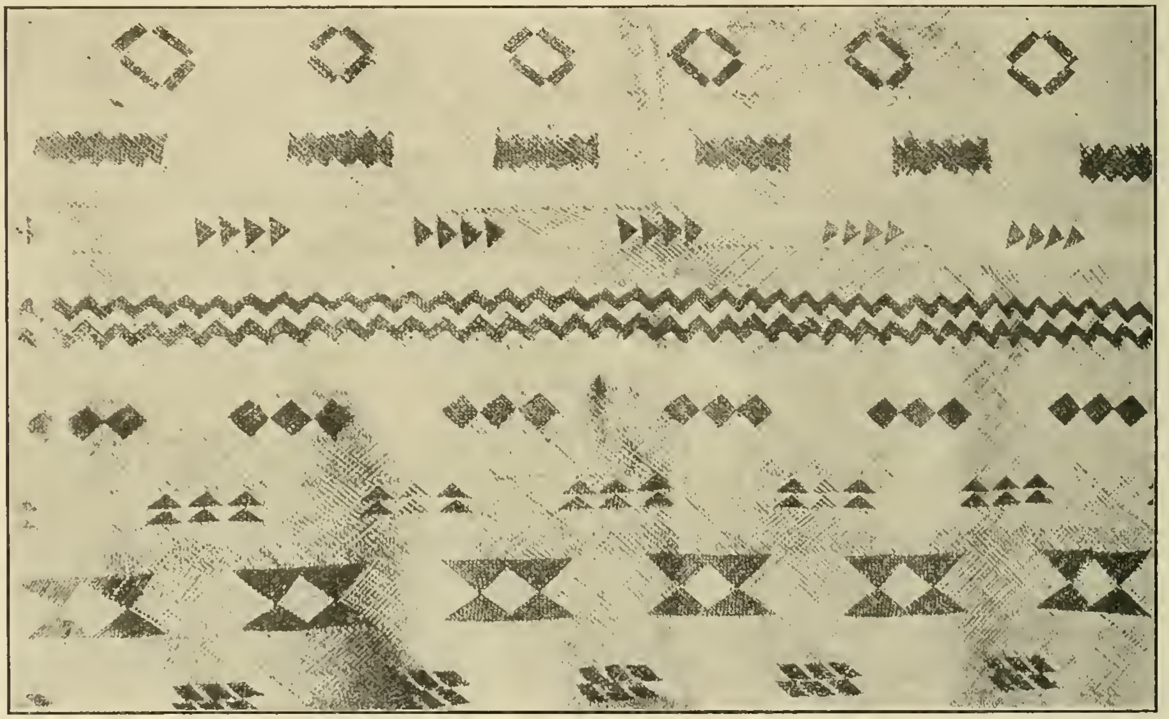


FIG. 77. NIIHAU MAKALOA MAT.

Keekee. Bent, zigzag; a favorite form, reminding one of the Egyptian hieroglyph for water. Fig. 78.

Olowahia. A saw; this is also a favorite design. Fig. 79.

Kuhanu. Breath of Ku (the god of war). Fig. 79. (Second and fourth band.)

Humuuniki. Squares joined. Fig. 80. (Central band.)

Papaula. Red row. Fig. 80. (Second band from bottom.)

Puakala. Rough, like the leaf of the *Argemone*. Fig. 80. (Bottom band.)

Hale = house. Fig. 81.

Nene = geese flying. Fig. 81.

Papa konane = checkers.

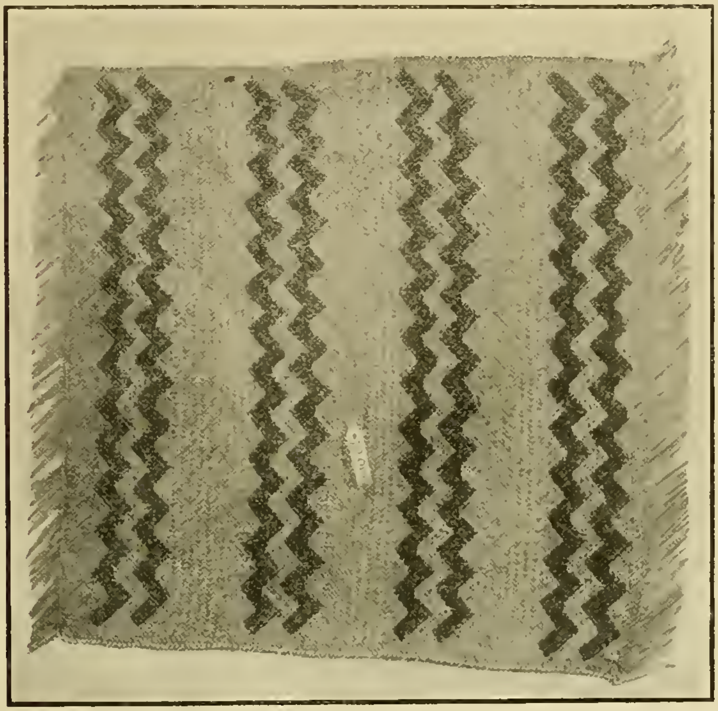


FIG. 78. KEEKEE PATTERN.

In some of the oldest mats the keekee and olowahia alone appear; in others the weaver seems to have exhausted her list of designs, as shown in Fig. 77 and Pls. XII, XIII. A combination of triangles was constantly used, either a large triangle made up of a series of smaller ones (Fig. 83B), or a row where the apex of one touched the centre of the base of the succeeding (Fig. 83G), or two triangles were arranged with the apex of each in juxtaposition (Figs. 80, 83D): the last was greatly used as a central dotting. The combination of triangles and squares, of which the distinctive name is not known (that is, they are not found in my note book of forty years ago) may be seen in Fig. 83, where the numbers there given are used in the descriptive list of the mats given below. After the islanders had learned to read, under the instruction of the American missionaries, the use of letters of the alphabet became common both in tatuing and mat decorating, and mats somewhat resembling the samplers of our grandmothers' days were woven. It soon became common to write affectionate greeting on mats intended as presents to friends, and I have seen a number of these. On sleeping mats I have seen embroidered the inscription "*Kuu ipo, kuu lei, kuu milimili e*" (My darling, my crown, my thing to be gazed upon). It is often difficult to decipher these mat inscriptions, as the technic prevents the use of curves, and the individual letters were of strange forms, and, like the ancient Greek inscriptions, there was not that separation between the words that a modern reader demands.

The largest mat in this Museum is No. 2574—30.5 ft. long and 14.5 ft. wide, but it is not of the finest weave (11 to inch); combinations of four squares and of eight triangles alternate over the surface. The smallest makaloa mat is No. 2601, a malo or waist band worn by a chief; it is about 9 in. wide and 6 ft. long, and of a fineness of 20 to inch. Another very ancient makaloa malo, No. 2600, from Queen Emma's collection, is said to be the identical malo worn by the Moi Liloa when he met Akahikameainoa, and which afterward became the token of the paternity of his son, the famous Umi.[21] It is a complete ruin, only being kept together in part by cementing to cloth, but the weave is very fine (31-34 grasses to the inch). The finest mat in this Museum is of great size (20×10.5 ft.), and has 17 grasses to the inch; it is as flexible as cloth, although more than a century old, and it was worn as a cloak or toga by Kamehameha the Conqueror, from whom it came to his descendant, Mrs. Bishop. Unfortunately it has been badly damaged by worms, a reminder that these mats quickly perish in this way if not carefully guarded, and perhaps the finest known collection of these mats was lately destroyed here by the negligence of the owner.

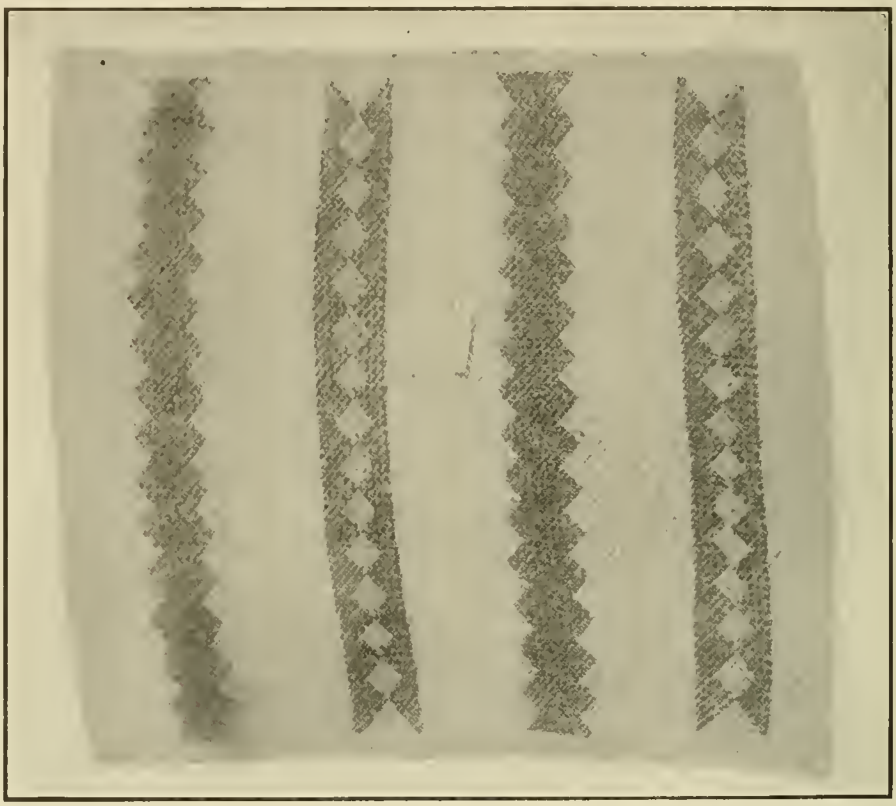


FIG. 79. OLOWAHIA AND KAHANU PATTERNS.

By comparing this with the fine pandanus mat from Samoa it will be seen that the choice production of the southern island is finer, but it is woven from narrow portions of leaf, while the makaloa of the Hawaiian is from the entire stem. It seems worth while to place in tabular form the principal mats in the Museum collection, that the great range of size, if nothing else, may be seen at a glance, and this collection is large enough to furnish specimens of all known varieties of this nearly obsolete mat. First I place the plain or unfigured mats (*pakea*) whether of uniform weave or varied with twills or other fancy weaving.

---

[21] J. Remy: Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands, Boston 1868, p. 18.

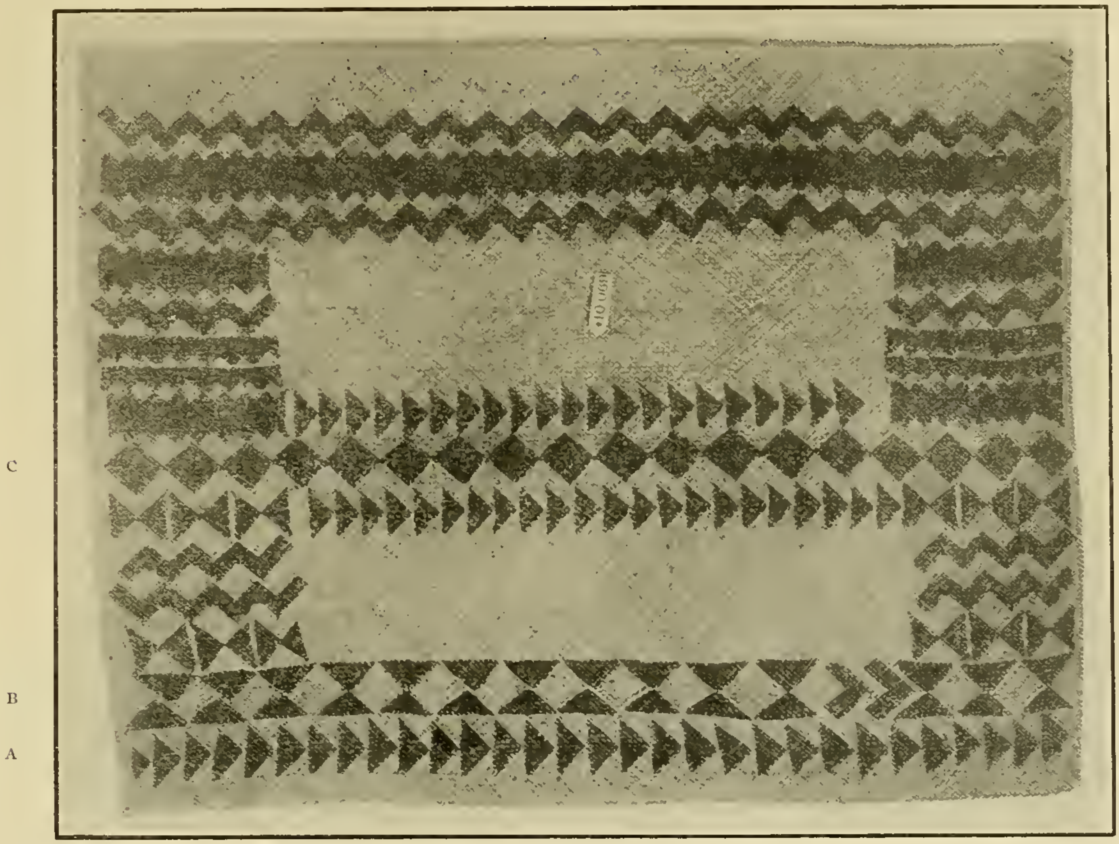


FIG. 80. PUAKALA (A), PAPAULA (B), HUMUNIKI (C).

PLAIN MAKALOA MATS IN THE BISHOP MUSEUM.

2550.	14.3 ft.×9.5 ft.	Carpet for floor or large hikiee.
2551.	10 ft.×7 ft.	
2552.	10 ft.×7.5 ft.	
2553.	12.2 ft.×6.5 ft.	Very old.
2587.	9.7 ft.×6.5 ft.	
2588.	20 ft.×10.5 ft.—17 to inch.	Belonged to Kamehameha I about 1780(?).
2589.	7 ft.×4.5 ft.	
2590.	6.5 ft.×5 ft.	From Queen Emma's collection.

7650. 8.2 ft.×7 ft.—9-11 to inch. Finely woven in many patterns.
7718. 11.5 ft.×9.5 ft.
2601. 5.9 ft.×0.5 ft.—20 to inch. Chief's malo or waist covering.

Moena Makaloa Pawehe in the Bishop Museum.

2554. 18.5 ft.×9.5 ft. Serrated longitudinal stripes. Leleiohoku collection. Fig. 83L.
2555. 7.5 ft.×7.2 ft. Keekee, olowahia and other stripes.
2556. 9.5 ft.×7.5 ft.

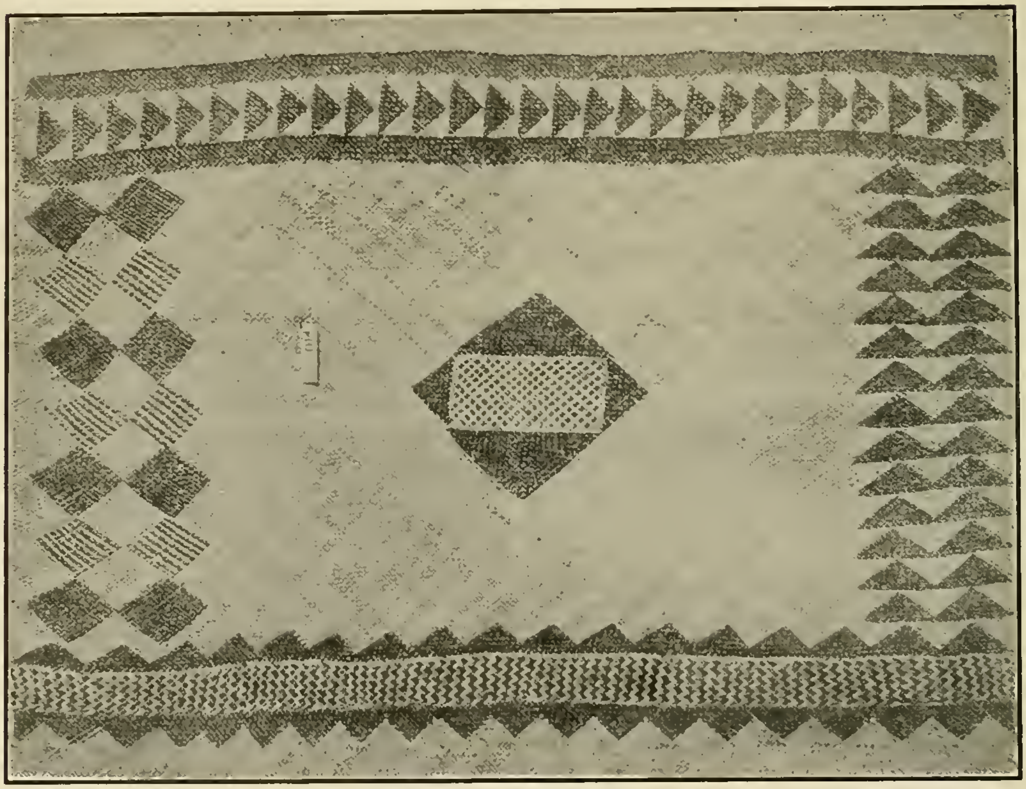


FIG. 81. MAT PATTERNS.

2557. 24 ft.×13 ft.—10 to inch. Broad and narrow long stripes. Given by Kekauonohi to Queen Emma's mother.
2558. 15 ft.×10.5 ft. Triangles variously arranged; border around all.
2559. 10.6 ft.×10.6 ft. Triangles in pairs all over. Fig. 83G.
2560. 7.7 ft.×6.5 ft. Compound triangles, rhombs and squares. Fig. 83B.
2561. 26 ft.×15.5 ft.
2562. 7.9 ft.×6.7 ft. Broad, compound bands.
2563. 13.5 ft.×11 ft. Papa konane all over. Fig. 83F.
2564. 9 ft.×6 ft. Weave plain and fancy; former triangles, olowahia, papaula, squares.
2565. 9.2 ft.×7.5 ft. Border of squares touching by angles. Fig. 83F.
2566. 27.6 ft.×13.5 ft. Triangles, rhombs and squares.

2567. 15.5 in.×7.7 ft. Keekee and four triangles apposed in pairs by points.

2568. 9.5 ft.×6.2 ft. Keekee, nene, plain double stripes and Fig. 83H.

2569. 9.2 ft.×6.7 ft. Broad stripes interrupted by rhombs and zigzags.

2570. 7 ft.×6 ft. Lettered all over, but the rude letters almost faded out.

2571. 7 ft.×6 ft. Stripes and keekee.

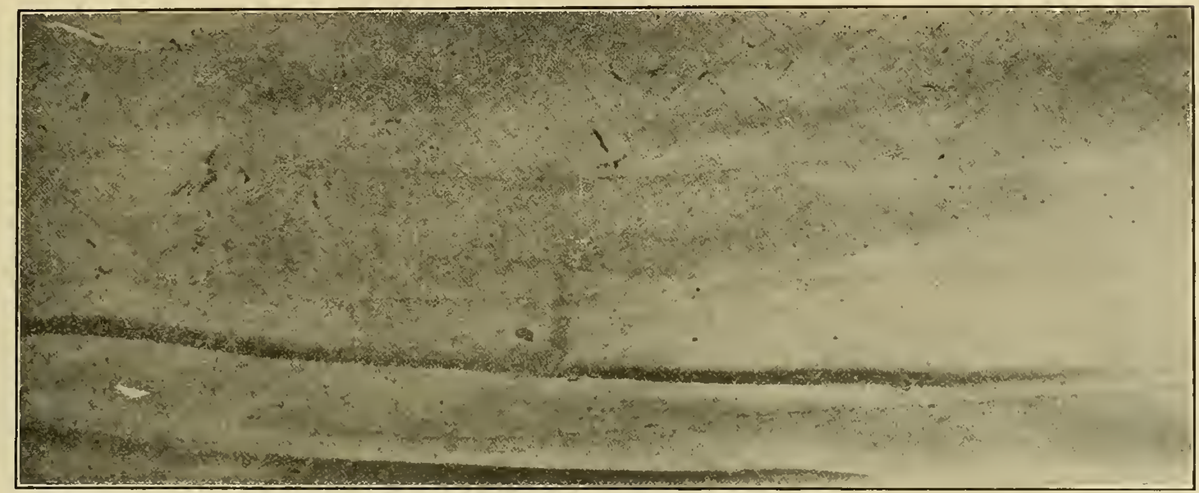


FIG. 82. MAT BELONGING TO KAMEHAMEHA I.

2772. 9 ft.×5.5 ft.

2573. 10 ft.×6 ft.

2574. 30.5 ft.×14.5 ft.—11 to inch.

2575. 11 ft.×9 ft.

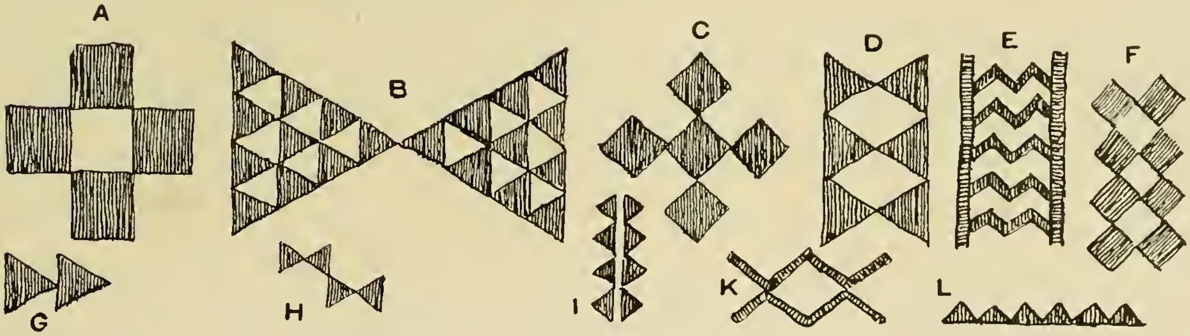


FIG. 83. MAT DESIGNS.

2576. 11.9 ft.×7.5 ft.—10 to inch. Keekee and olowahia in short stripes.

2577. 10.5 ft.×7.5 ft.—11 to inch.

2578. 8.5 ft.×6.5 ft.

2579. 11 ft.×7.5 ft.

2593. 10 ft.×7 ft.

6878. 9.3 ft.×6.7 ft. Keekee and olowahia stripes.

10,072. 9.2 ft.×6.7 ft.

6633. 8.5 ft.×6.5 ft.—12 to inch. Triangles, squares, etc.

6634. 9.2 ft.×6 ft.—9 to inch. Stripes and raised bands.

Coarser mats were made from akaakai (*Scirpus lacustris*) of which abundance is found in the marshes around Honolulu. These were used as mats for temporary purposes, or sometimes for the lower layers of the hikiee bed, but they were not durable and the surface was soon destroyed. The following are examples from the Museum collection.

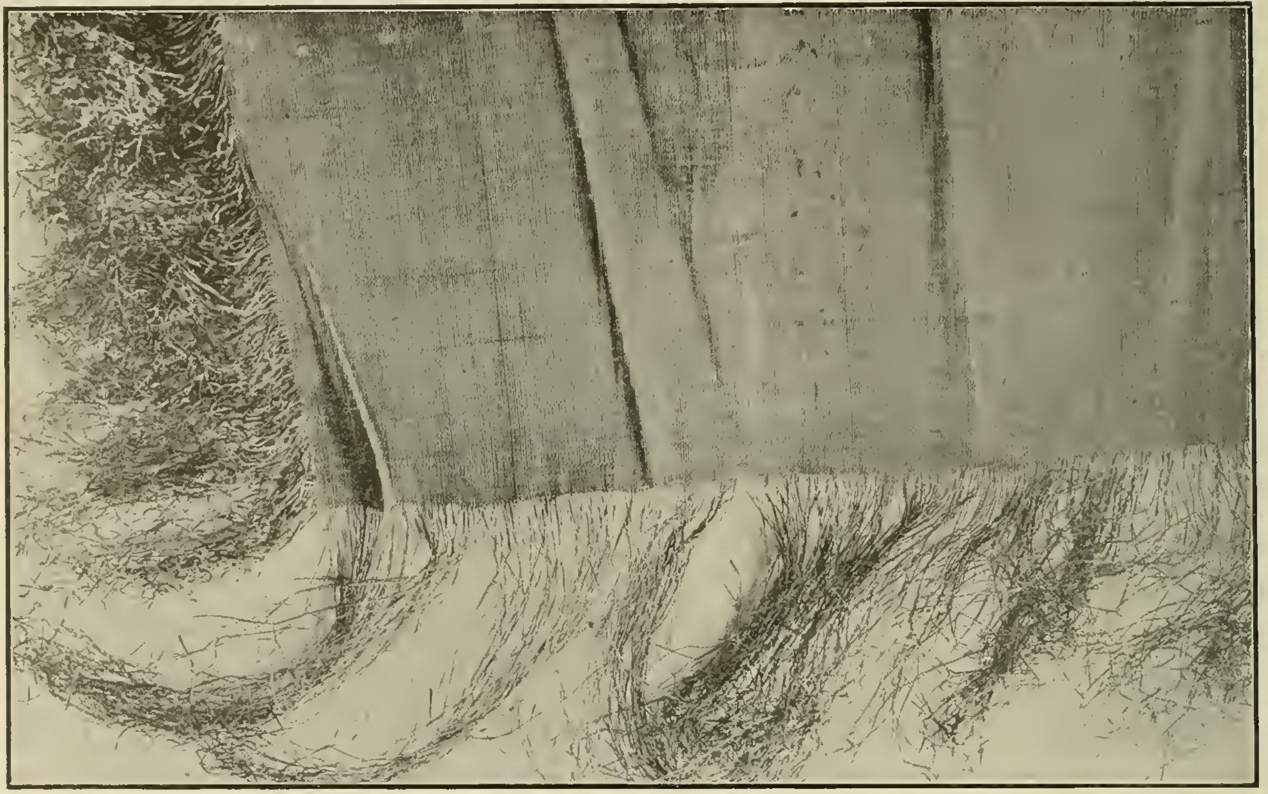


FIG. 84. GRASS MAT.

MOENA AKAAKAI IN THE BISHOP MUSEUM.

2584.	5 ft.×2.5 ft.
2585.	6 ft.×6 ft.
2594.	10 ft.×8 ft.
2595.	8.7 ft.×7 ft.
2596.	20 ft.×10 ft.
2597.	9.5 ft.×7 ft.
6635.	11.6 ft.×9.3 ft.—7 to inch. Heavy floor mat.

Grass Baskets are not much in evidence as an Hawaiian product, but in the Bishop Museum is a very pretty basket from Maloelab (Calvert's Id.) in the Marshall group, No. 3347 in Pl. I. This is said to have been produced in 1849 and has been somewhat of a puzzle as to its constituents. It is small, height 4.7 in., diameter 3.2 in., and the bottom is a close ordinary weave of a dark brown grass which also is gathered into vertical rods and horizontal coils, these two elements forming a trellis not interwoven but the vertical rods are all outside and the horizontal rings all inside; over this trellis runs a sewing strip in four colors, straw, chocolate, white and yellow. These various colored strips seem to be split straw, but I have not definite knowledge of them or of the dyes used. The ornamental bands are shown in the plate, the dark is always chocolate; the interior of the upper band is half straw and half white, of the lower band, yellow. The vertical rods are closed in at the rim by a braid which conceals the ends. The interior is rough where the ends show: there is no handle nor cover.

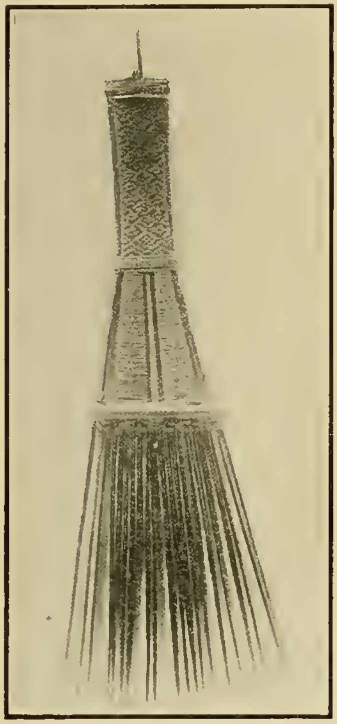


FIG. 85. COMB OF PALM WOOD AND GRASS BRAID.

Solomon Islands Grass Work.—Although authors have stated that the beautiful braids of black, red and yellow material that the Solomon Islanders are so fond of using to adorn their choice spears, clubs and, in curious company, their combs, was from the stem of a species of fern (*Gleichenia*),[22] it now seems settled that it is a grass, species unknown, that is used. We have in the Bishop Museum a parcel (No. 8287) of the dyed grass used in this work brought from Bougainville by our collector. The native name is *latile*, and it seems to have a semi-sacred nature for it is used to form amulets, and perhaps hence its appropriate use in choice spears and clubs. It is said to be dyed with lime and the root of a certain tree (*Morinda?*). The dyed grass averages 27 inches long, and the leaves on stem split readily showing a considerable rough fibre beneath the smooth surface.

Although the clubs and spears show a great deal of fine work, I am inclined to give the palm to a comb in this Museum, No. 1941, shown in Fig. 85. This is made of the usual palm splints (not whalebone as mentioned by some authors), and of a form well known in collections. This particular specimen was collected on Bougainville fifty years ago and is 7.5 in. long. The design is alike on both sides, but in the narrow portion of the handle the colors yellow and black are reversed on the side not figured. The two bars of the lower portion are red embroidered with yellow. The braid at the base and around the upper and middle portion is brown. The illustration unfortunately can give no adequate idea of the color and the beautifully exact and appropriate design. Another specimen (No. 6329) is smaller (6 in.), and although made on a plan similar to the preceding shows signs of deterioration in the workmanship: it was collected in 1903.

[22] Ling Roth, Spears and other articles from the Solomon Ids. Archives Intern. d'Ethnologie, xi, 154.

One of the fine spears in the Solomons collection has twenty-four bands of woven red and yellow covering, separated by plain circumferential bands and exhibiting perhaps six or seven different designs. An implement called a "chief's wand or sceptre" has ten of such woven bands. The weaving on the clubs of lenticular section is very exact and tense or it would soon get loose on the tapering body, unless, as sometimes seems to be the case, it is cemented on. Spears with carved head inlaid with pearl shell often have a narrow band of this finely woven covering.

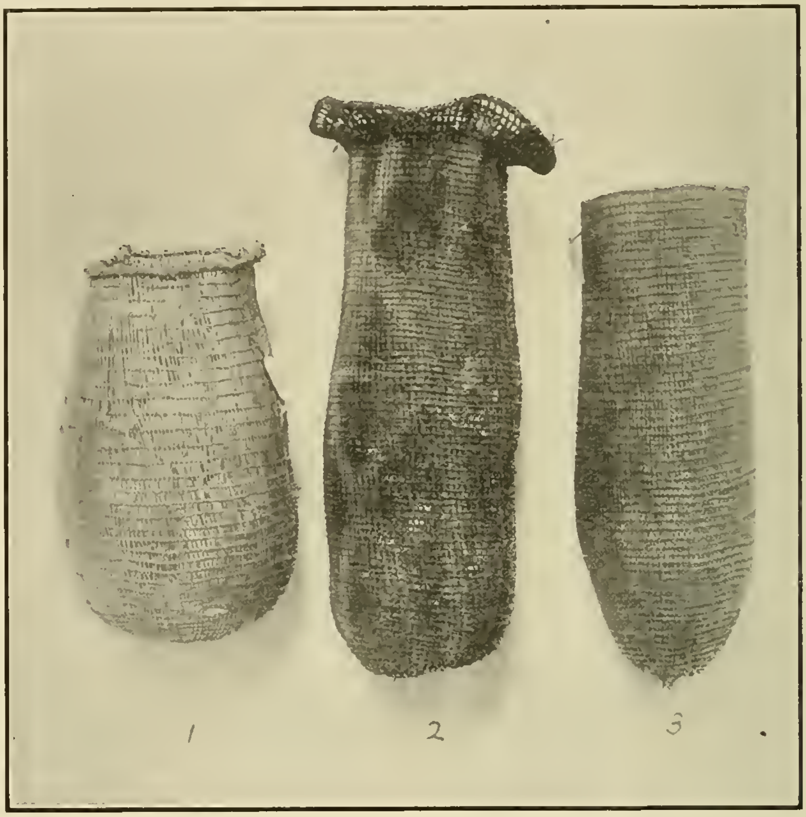


FIG. 86. BASKETS FROM NORTHERN AUSTRALIA.

Bambu Work.—We may now return to Hawaiian matters. Modern fans are often made of split bambu which affords thin laminæ separating much as does the paper birch bark of our northern regions. These strips, of varying width and length according to the use intended, are very beautiful and the fans made from them (which are perhaps much less beautiful than the bambu strips of which they are constructed) are shown in Plate XV, where Nos. 19, 22-24, in the lower part of the plate, are of this material. The brilliant white is often contrasted with the outer skin of the black banana. A golden brown fern stem is also used in these fans for color effects. The banana is shown in No. 19, and the fern in No. 7.

Sugar Cane.—An uncommon but very beautiful material for braids used in hat making is found in the sugar cane. This grass was found on these islands by the early voyagers, but so far as I am aware its use in basketry is modern. The strips are very glossy and become, by age or exposure to the sun, a golden brown. Cane leaves have long been used for thatching the native houses, but are less easily worked and much less durable than the common pili grass.

Australian Baskets.—All through this account of Hawaiian basket and mat weaving illustrations have been drawn from other Polynesian sources, nor has that been the limit, for Micronesian and Papuan sources have also been freely taxed in order that perchance the geographical origin of certain forms or methods might be indicated: and for this it seems as important to show the work of tribes within the Pacific area, even when that work appears widely divergent from that forming the basis of this treatise. If we had a fairly complete collection of Pacific basketry, such as this Museum is striving to gather, much might be gleaned of the traces of ancient intercourse, if not of common origin, of the tribes whose descendants are now verging toward extinction on the islands of the Pacific. This would be truer of baskets than of mats, for the latter have always been deemed of greater value as property, and have always been favorite objects of barter or of plunder. Reference has already been made to the care bestowed by the old Samoans on their choice mats and the great length of time during which they have been preserved. The baskets seem to have been made under a less favoring star, and however useful, however ornamental they may have been, they certainly have not stood so high in the estimation of their makers or owners as have the mats. Perhaps enough of the human has clung to them from the busy fingers of their makers to impart to the senseless intertwined and knotted strips the usual human lot, where the quietly *useful* people are, when dead, soon forgotten, while the brazen warriors or the astute politicians are preserved in marble or bronze or *aere perennius* in the pages of history.

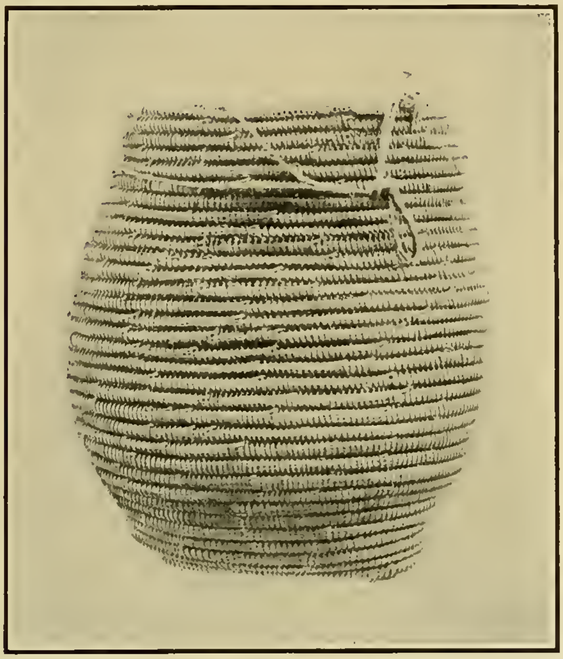


FIG. 87. COILED BASKET IN THE AUSTRALIAN MUSEUM.

The coiled form of basket, so common among the Amerinds, is also found sporadically in the Pacific regions, as at Fiji, New Britain, New Guinea, and here in Australia. All the Australian coiled baskets that have come to my notice are knotted coiled, that is, the thread that unites the adjoining circles of the coil are knotted between the coils, as shown plainly in Fig: 87, or perhaps better in the specimen in this Museum given in Fig. 88. In all the foundation of the coil is some small fibre or grass, to which I am unable to give a name, and the connecting thread has much the appearance of rattan, and is perhaps from some vine allied to the *Calamus*. The best description of these and other Australian baskets is found in R. Brough Smith's Aborigines of Victoria,[23] and in the account of certain decorated baskets by R. Etheridge in the Archives internationales d'Ethnographie.[24]

In the specimen in this Museum (Fig. 88) the shape varies a little from that shown in Fig. 87, which is more like that figured by Smith. Here the diameter is 10 in., height 6 in., with a handle of Eucalyptus fibre (*Eucalyptus obliqua*) network. The native name in Gippsland is *Minni-gual-ok*. This old form is now scarce, as the native women make them with many modifications to sell to whites. This basket is strong and elastic but not finely made. A peculiar form of coiled basket is shown in Fig. 89. This was formerly common among natives of South Australia but now rarely seen. Eyre says that in one part of South Australia this basket is called *Pool-la-da-noo-Ko*.[25] Two are in this Museum; the one figured, No. 1916, is 8 in. in diameter, and is decorated by spiral stitching; the other is of the same diameter but has a neck of three coils, and is also decorated by red stitching. In both the handle is formed by a continuation of the coil. As to the material, Smith says that both *Poa australis* and *Xerotes longifolia* were used for basket making. In Fig. 89 is also shown a common form of basket of which two are in this

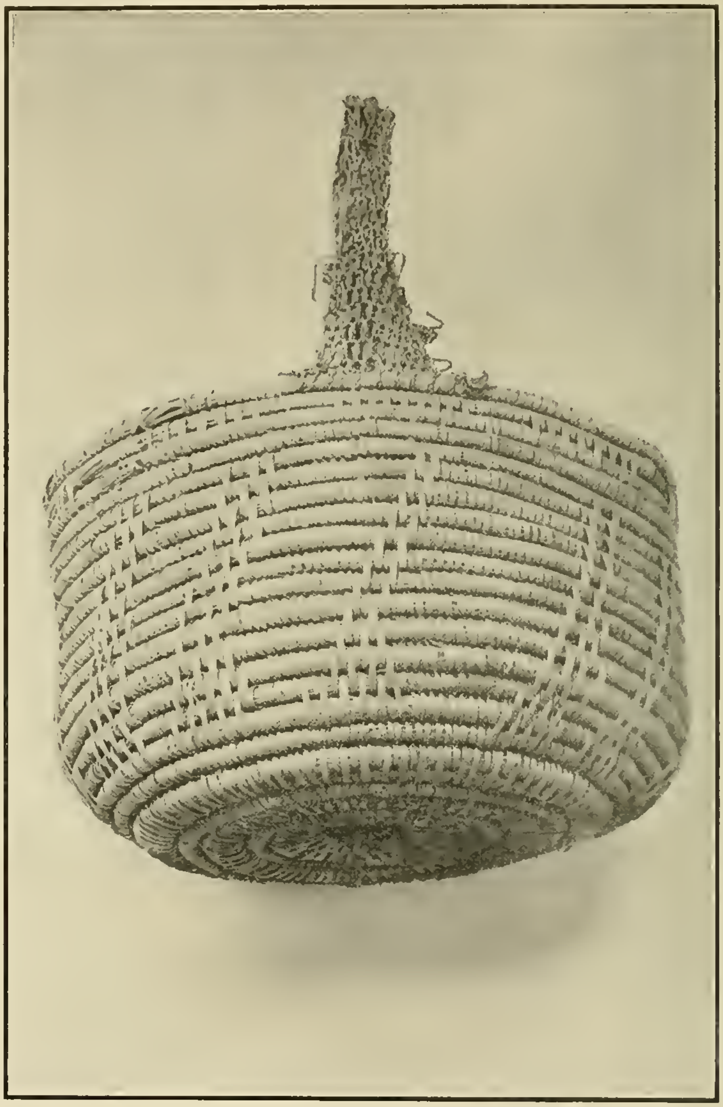


FIG. 88. COILED BASKET FROM GIPPSLAND.

---

[23] R. Brough Smith, The Aborigines of Victoria. Melbourne, 1878, vol. i, p. 345.

[24] Archives internationales d'Ethnographie, xii, p. 1. On the Ornamentation of some North Australian "Dilly Baskets." A study in Australian Aboriginal Decorative Art, by R. Etheridge, Junr., Curator Australian Museum, Sydney. Mr. Etheridge has also described the manufacture of baskets in the Macleay Memorial, vol. Linn. Soc. N. S. Wales, 1893, pp. 247 and 249.

[25] Aborigines of Victoria, p. 345.

Museum. In the one figured, No. 7430, from Queensland, the weave is quite open, and the basket at the mouth measures 8.5 in., is 12 in. high, and 14 in. between the points. The handle, attached to one side only, is of white strip long enough to go over the shoulder. The other specimen is larger, measuring 10 in. at the mouth, 14 in. high, 16 in. from point to point. In both the handle is securely fastened to three of the regular ribs and to an additional rib inserted for strengthening this attachment and extending only half around the basket.

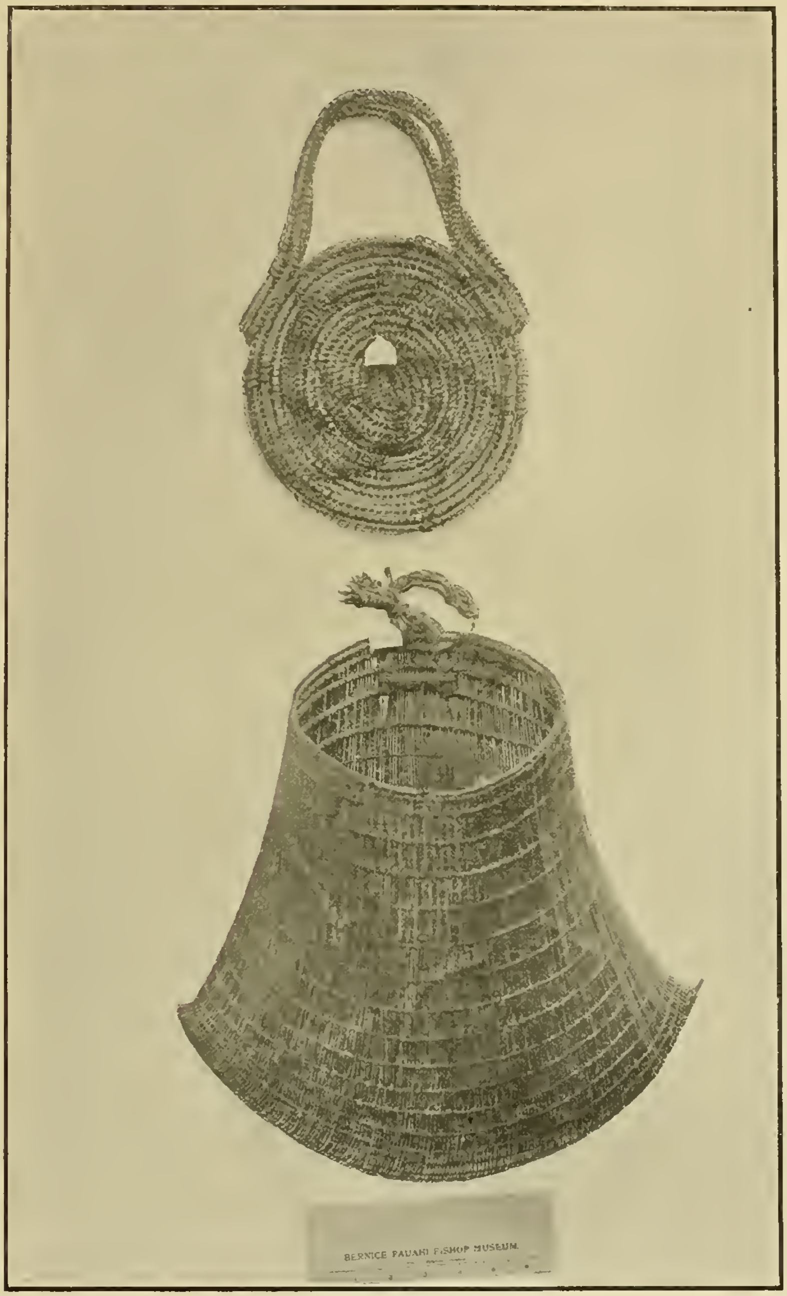


FIG. 89. AUSTRALIAN BASKETS.

The choicest of all the Australian baskets are those known as "Dilly Baskets" and used to carry the small tools and treasures of the owner. Three are figured in Fig. 86 and another in Fig. 90. Seldom of large size, they sometimes are very small; in one figured by Etheridge (*loc. cit.*, p. 5) the length is only 6.7 in., and the mouth only 1 in. in diameter. This little basket was decorated by first coating the entire surface with Indian red pigment and then with lighter red, white and yellow, the ornamentation was completed. The Australian Museum possesses this gem of Australian, basketry. Of the three dilly baskets shown in Fig. 86, the first, No. 8741, is 9.5 in. long, and 5.5 in. in diameter. The structure is loose but strong, of a grass-like fibre and this particular variety is often much larger, as shown in a specimen in this Museum, No. 8740, unfinished, which measures 18 in. long by 14 in. in diameter. The second specimen, No. 8750, measures 13 in. in length by 5 in. at the neck, and 7 in. through the collar. It is decorated with white lines on a dark red ground. No. 8756, the third in the figure, measures 12 in. long, with a diameter of 5 in.; the original decoration of red zigzags is nearly obliterated. These three dilly baskets were collected by Mr. Harry Stockdale, of Sydney, in the Alligator River District near Port Darwin, and are now in this Museum. From the same district, also from Mr. Stockdale's collection, No. 8755 comes to this Museum, and it is a choice specimen of the most elaborate decoration of the Australian basket makers. Unfortunately the method of coloring does not prove lasting, and the pigment rubs off much in the manner of ordinary whitewash; still in this specimen, as may be seen in the illustration, Fig. 90, enough remains to show that the skill of the decorator was above the ordinary. The decoration does not extend quite around the basket and is divided into five zones, the upper one composed of one horizontal and a number of vertical white lines; below this seven vertical lines, rather shorter than the last, flanked by two rosettes and what seems to be a hunting scene. Then comes a corroboree in which the male figures are quite distinct; then a band of confused figures,

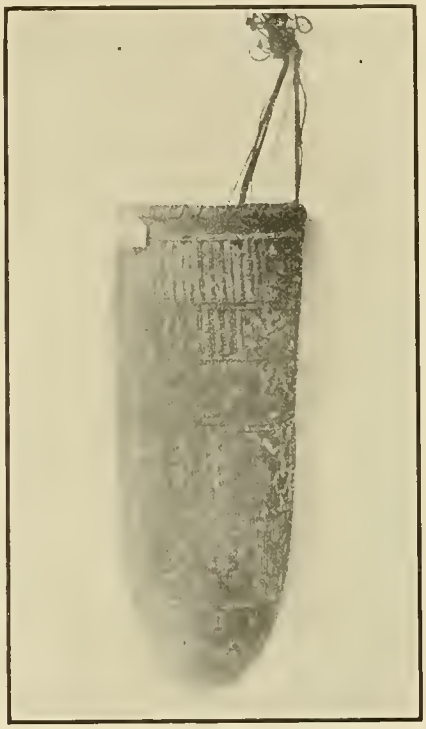


FIG. 90. DECORATED DILLY BASKET.

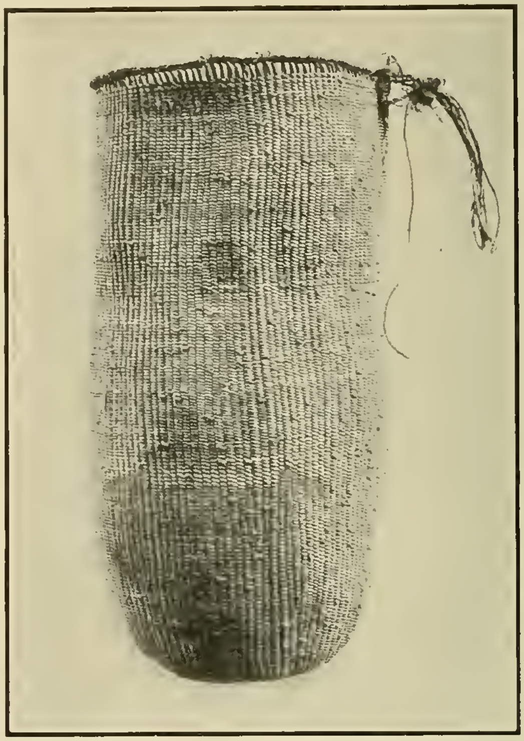


FIG. 91. PLAIN DILLY BASKET, AUSTRALIAN MUSEUM.

and the curved base of the basket has a row of white squares, then a zigzag line below which are other triangles and dots. The basket is closely woven and of good form. It does not seem to have been figured by Mr. Etheridge, whose familiarity with all forms of Australian decoration might have explained more clearly the designs. A more complete description of this important basket is as follows:

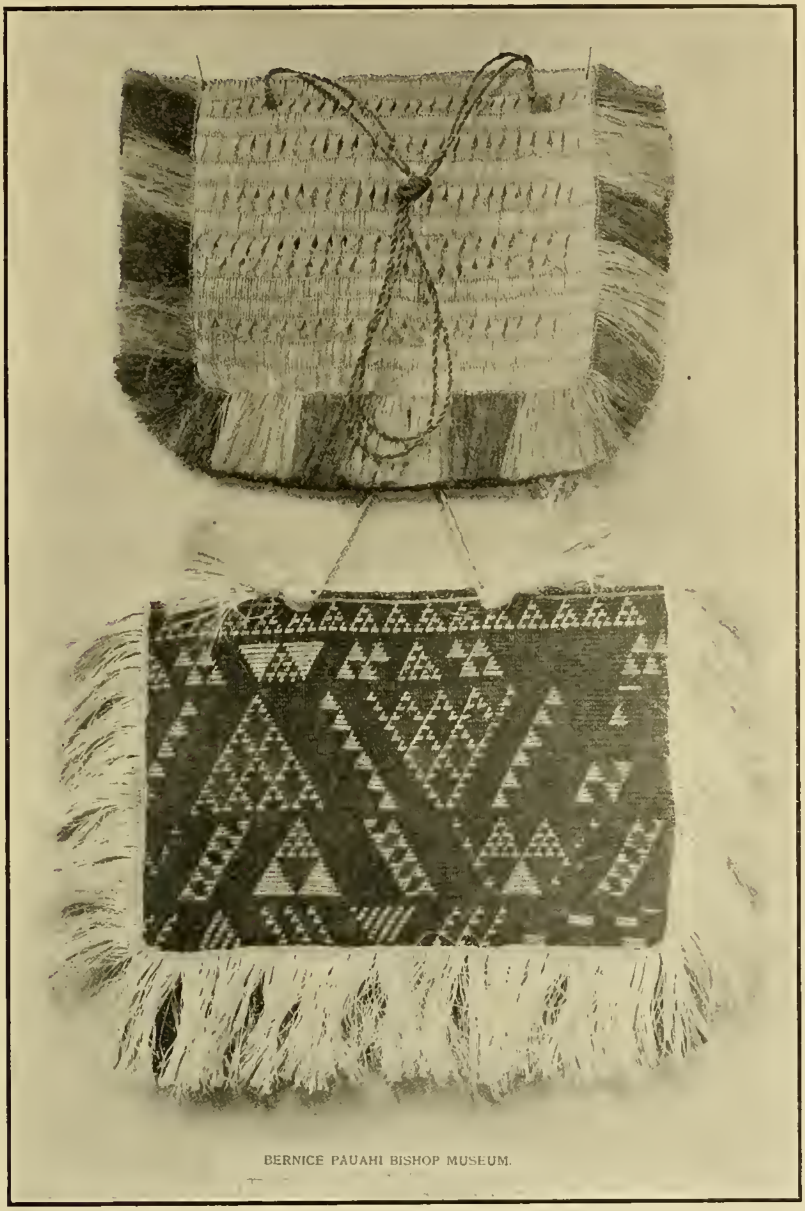

BERNICE PAUAHI BISHOP MUSEUM.

FIG. 92. KETE OF HARAKAKE FIBRE.

No. 8755. Length 14 in., diameter 5 in., rounded bottom. Upper rim sewed with stout twisted cord: surface divided into seven zones by double raised bands; painted dull red, on which ground are black and white designs which extend over more than one-third of the circumference, and there are indications of other marks on the side worn next the body now undecipherable. Upper zone narrow and plain; second has 14 vertical white stripes and rosettes at each end of the series; third has 7 similar stripes, but shorter, and with rosettes at each end; fourth has what seem to be hieroglyphics(?); fifth has a corroboree with 5 male figures; sixth has confused marks, unintelligible; seventh has 7 rectangles forming a zigzag with a figure in the midst resembling a three-barred gate, triangular spots within lower angles of band which extends two-thirds of the circumference; 5 square spots above the band and the same number below, this zone ending in 5 concentric rings. Inside of basket unpainted; carried by five cords attached in two places on one side of the rim.

A plain dilly basket in the Australian Museum is shown in Fig. 91 by the kindness of Mr. Etheridge. It has a rather flatter base than the others, and the rim is slightly detached from the filling.

New Zealand Kete.—The so-called "flax" of New Zealand (*Phormium tenax* Forst., native *Harakake*) is one of the most important commercial fibres of the Pacific region. This liliaceous plant, of which the observant old Maori distinguished fifty or sixty varieties, and the botanists note two species, grows wild over a vast extent of marshy land in New Zealand, and the traveler through the North Island sees the plant with its tall flower stems on every side. Indeed on landing at Auckland one sees bale upon bale of the attractive looking fibre awaiting shipment. It is unnecessary here to go into the commercial preparation of the fibre for several full accounts of this are accessible,[26] and we need only present some of the products made from this raw material in the line of our present study.

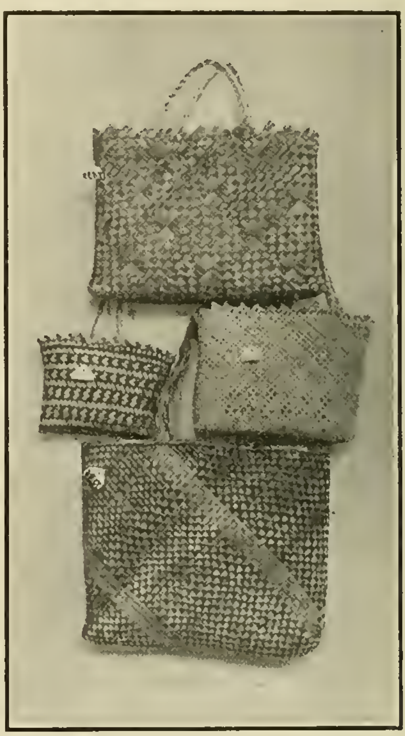


FIG. 93. MAORI SATCHELS.

Kapa or bark cloth made of felted fibre was useless in the cool and wet climate of New Zealand, and the Polynesian immigrants must soon have devised a way to utilize a fibre as beautiful as it is tenacious and durable. It is often stated in books on New Zealand that no implement or machine can clean the fibre with the perfection of that very primitive tool a Maori thumbnail, and while this is true in a sense it must be acknowledged that modern machinery certainly turns out a very fine product.

It would be very interesting to go more fully into an examination of the weaving of the wonderful cloaks, of which extraordinary examples are in this and other museums, but this has been well done by Mr. Hamilton, now Director of the Wellington Museum (*loc. cit.*, p. 271), and his illustrations show the perfection to which the native manufacture attained. There was no loom, but the pegs (*turuturu-parawai*) which held the web for the webster during weaving were often grotesquely carved. I have, however, thought best to give some examples of the *kete*, kits or satchels, in this weaving as they illustrate the work as well perhaps as the more elaborate cloaks. Fig. 92 shows two of these, the upper one, No. 5819, is of bleached fibre mingled with a portion dyed yellow (with a *Coprosma?*). The weave is very simple and effective, as can readily be seen in the illustration. In some remarkably fine and costly ones that I found in the Taranaki district the weaver had introduced the beautiful cone of

[26] Elsdon Best, The Art of Whare pora Maori flax weaving: Trans. N. Z. Institute, xxxii. A. Hamilton, Maori Art, quotes largely from Mr. Best's essay. See also the Reports of the New Zealand Flax Commission. Sir James Hector, Phormium tenax, 1892.

Mt. Egmont in a triangle as easily recognized as the innumerable representations of Fujiyama in Japanese decoration. In the lower example in the same illustration, No. 1590, the white and glistening fringe admirably sets off the black body of the kete, through which are woven patterns of the Maori tribal tatauing, and these patterns are not less interesting for their coincidence with many of those embroidered into their makaloa mats by the Hawaiian women as shown in Fig. 83. It may simply mean that a triangle is an easy figure for the technic of the mat, but the resemblance is there between the ancient decorative forms of the two Polynesian families now at diagonally opposite parts of the Pacific.

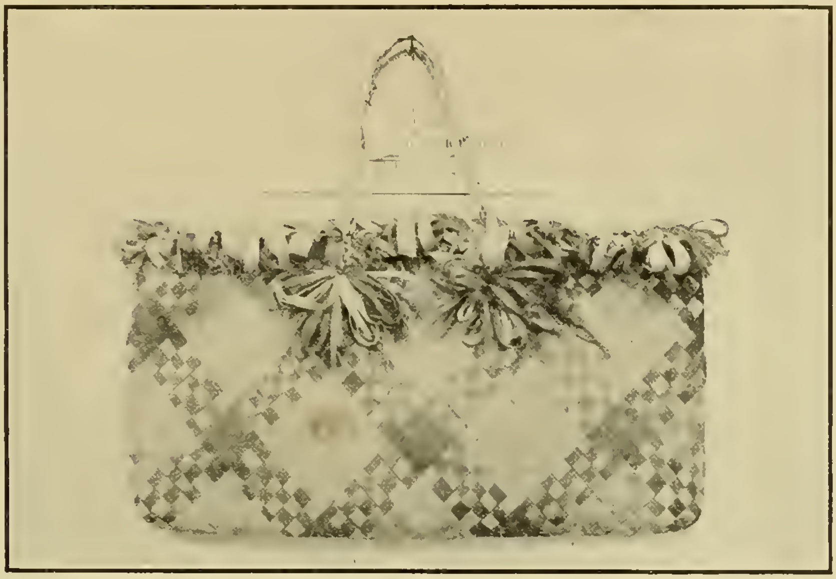


FIG. 94. MAORI BAST SATCHEL.

Many pages might be devoted to a description of the various ways in which the long flat leaf of the Phormium is used in garments waterproof and ornamental, of which this Museum has a fine collection, but these are not strictly either mat or basket work, and we must pass to the use of the leaf in basketry where it takes the place of the pandanus of warmer climates. Fig. 93 shows several of these and they are still made of every size and variously decorated. The larger ones in the illustration, Nos. 7585–86, are woven inside out from the bottom and then turned, leaving a rough seam within. No. 7588 is, I think, made of Nikau palm. The two small satchels are woven without the bottom seam. The handles of all except the bottom one are of harakake fibre; of that the handle is of twisted leaf. The leaves of the so-called cabbage-palm (a *Cordyline*) are also used in making these satchels and for other similar purposes, but they are not so flexible as the harakake leaves.

It is not only the leaves but the flower stems that are useful in Maori mat work, for the panels between the sculptured slabs in the carved houses of the Maori are made of these cylindrical sticks combined in great variety.[27] This is due either to alternations of color in the sticks, or depends on the arrangement of the strips that bind these together. New Zealand is often described as a group possessing a wonderful variety of woods both useful and ornamental, and I am tempted to give a single example of what might be regarded as a refined "splint" basket. Fig. 94 shows No. 6562 which is simply woven of the bast of *autetaranga* (*Pimelea arenaria*). It is light and perhaps flimsy, but none the less artistic and attractive even as a mere ornament.

---

[27] Hamilton, *loc. cit.*, p. 86, Pl. xiii. These panels were called *tukutuku*.

Fibre Mats.—Passing again from the Hawaiian group, where mats of fibre were not made, to Samoa, a group so closely allied to the Hawaiian in language, customs and physical form, we find the fibre of the bast of the fau (Samoan *fau*, Hawaiian *hau*=*hibiscus*) used for fine mats which were greatly valued. The Hawaiians knew the hau and used its fibre for many textile purposes, but did not reduce it to its constituent fibres, a process well known to their southern brethren. Far to the west of these Polynesian groups the people of Micronesia, as we shall see presently, made great use of the hibiscus bast divided into fine strips, although not made into threads as in Samoa. On the latter group the *ie sina* were woven by hand, without implements, and while sometimes made of the unbleached bast strips, as No. 2193, in this Museum, they were usually of fine thread made by pounding the bast and then bleaching the fibre until it is as white as well cleaned banana fibre. In No. 2186 the finished mat is dyed with ochre or some other dye producing a red-brown color.

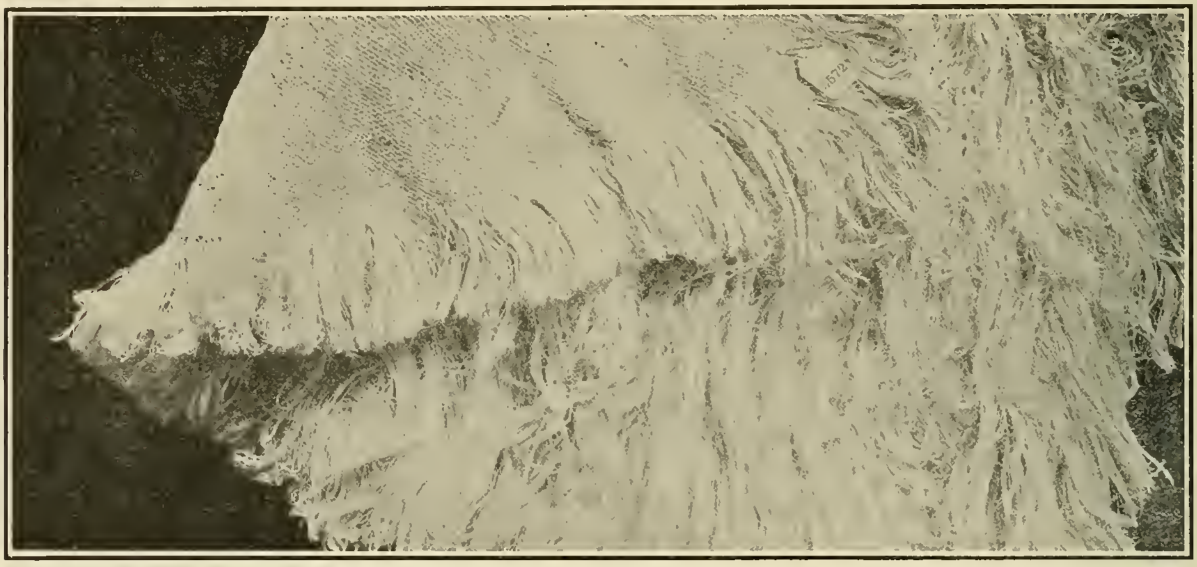


FIG. 95. IE SINA, SAMOA.

Not only were these mats of comparatively fine weave, but their substance was more than doubled by a nap or pile put on after the mat was woven by passing a parcel of the fibres with a full turn about a mesh of the mat at suitable intervals, and these can be pulled out only by loosening the loop formed about the mesh; pulling on the ends only tightens the hold on the mat. The length of this nap was variable, but in

No. 3570 it is seven inches, and the resultant mat looks like a sort of vegetable fur, as may be seen in Fig. 95, and like fur would make fairly warm and comfortable garments. For presents these mats were greatly valued, but their use in the curious "Tokens of Virginity" custom adds especial interest to the ethnologist, and it is not uncommon to find them stained with human blood. Of those in this Museum the following list shows size and fineness:—

SAMOAN IE SINA IN THE BISHOP MUSEUM.

2193. 4 ft.×3 ft.—9 to inch. Unbleached, unheckled bast.
2185. 5 ft.×3 ft.—17 to inch. White, fine fibre.
3570. 6.1 ft.×4.2 ft.—11 to inch. White, fine fibre.
3571. 5.7 ft.×3.7 ft.—9 to inch. White, fine fibre, coarser weave.
3572. 6.7 ft.×3.5 ft.—13–18 to inch. White, fine fibre, repaired.
2186. 4.7 ft.×3 ft.—10 to inch. Dyed, fine fibre.

The weave is so loose that it is easy to increase the width at the expense of the length, so that the measurements are approximate only.

Loom-woven Mats.—From the Gilbert Islands on the east to Guam on the west we find a rude but efficient loom for weaving fine mats, while throughout Polynesia no looms are used, and deft fingers must plait together the strands of whatever material to form a mat. With leaf strips or grass stems this is not very difficult, but with fine flexible threads the difficulty is increased, and the finer the thread the greater need of some mechanical assistance which the loom bars, however simple, and the shuttle afford. Two types of weaving apparatus are found in this region, one which is a loom in all its features, from which can readily be traced the more complicated forms of the modern textile art, and a specimen from Ruk in the Caroline Islands is shown in Fig. 96; the other, which, so far as I am aware, is confined to the island of Kusaie, is a very different contrivance, and although I have two specimens in the Museum before me, I cannot understand fully its working, nor have I been able to gather from those who have visited Kusaie any intelligible facts regarding its employment, and of this type Fig. 98 presents an example. Under ordinary circumstances one should be able, when he has the tools used and the finished product, as in the present case, to connect the two, but in this I have failed, and the Masters Finsch, Kubary and Parkinson, who have explored that region with ethnological skill, have failed to help me. The latter gives a full and interesting account of the first loom,[28] and from his account I shall take the liberty of quoting all that may explain more fully the loom before us and its work. It is interesting to find that on this island of Ontong Java, which was named by Tasman in

---

[28] Nachtrage zur Ethnographie der Ongtong-Java-Inseln, B. Parkinson: Archives Interna. d'Ethnographie, xi, p. 207. In a note on p. 242, a figure is given to show the horizontal position in which this loom is used.

1643, although previously seen by Mendaña, the inhabitants appear to be of Polynesian origin (and the figure of the weaver referred to in the note is strongly Polynesian), and the men are the websters, while in Polynesia proper the mat weaving is the women's work. Here then is a Polynesian family who have adopted the loom of their neighbors without alteration or improvement, and the question not unnaturally arises how it is that none of the other tribes did the same thing, if they all entered the Pacific through the western gate?

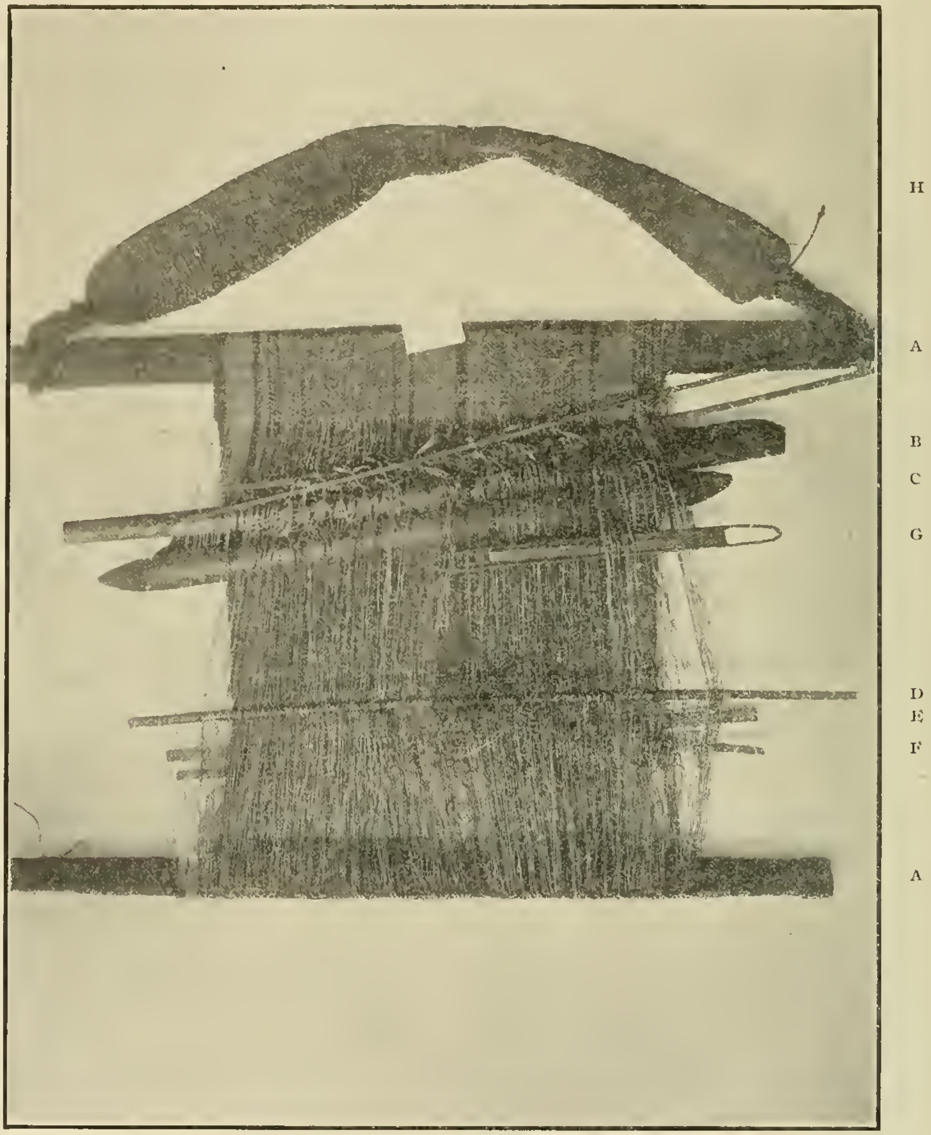


FIG. 96. LOOM FROM CAROLINE ISLANDS.

In all these simple looms the warp-beams are two sticks of equal and suitable length called *o*. In the simplest form in this Museum these are lengths of the light and smooth stem of some large palm leaf, but in the better one figured they are of heavy wood cut with some care and knobbed at the ends (Fig. 96, A). The widest of these seldom exceed three feet, and those of Santa Cruz are hardly a third of that length. Around these pass the longitudinal fibres or warp; these are continuous and slide on the beam. The length of the warp determines the length of the mat, and the number of warp threads its width. The beams armed with the warp are stretched in a horizontal position, one being held by cords passed around a post or tree, and the other by a belt or sling (H) which passes behind the back of the weaver, who is seated on the ground, so that he can easily regulate the tension on the warp. There was no yarn beam and cloth beam as in American and European looms of higher development; the whole fabric, warp and completed mat, was free to move over both beams like an endless apron. A similar arrangement is found in the Zuñi loom.[29] The slings are called *ku'u*. Next the weaver are two bambu sticks, about an inch wide, called *api* (B), thrust through the warp, so as to separate this into an upper and under layer. This would be sufficient in the simplest loom, but usually a rude heddle or harness, *ua*, (the sticks next the upper beam in the figure), consisting of a thin stick with a continuous cord looped along its length, and through these loops every other thread is passed before the loom is set up. In more complicated looms there are often many of these heddles through which varying portions of the warp pass and which are lifted at suitable intervals by machinery. In our present loom this motion is by hand, and it operates to "form a shed" by raising alternate threads from their neighbors far enough to allow the shuttle, *si'ia* (G), on which the filling or woof, *ogo si'ia*, is wound, to be thrust between the two layers from right or left. When the shuttle has passed, the third process comes into play,—the thread left in the shed (lay) is beaten up with a lathe or batten (D). Often the shed is formed, as in the loom from Ontong Java, by a sword-shaped strip of wood, *laga*, which the weaver holds in his right hand and therewith separates the layers of the warp so that the shuttle can easily slip through, and also serves to press the last thread of the woof close to the preceding one. This cycle constantly repeated completes the weaving. Of course the threads that were lifted for the first passage of the shuttle with the woof are depressed for the next passage, or, what amounts to the same thing, the others are lifted by being passed through another harness. When the shuttle is emptied of filling another is substituted, and the junction of threads is made by a neat knot precisely as in the more complicated loom of modern factories.

That my readers may have the full benefit of the German description, I give here the important portion of Mr. Parkinson's account:—

> Die einzelnen Theile des Webeapparats auf Ontong-Java folgen in nachstehender Anordnung. Die Kettenfäden (*Hau*) sind um zwei runde Hölzer geschlungen, welche etwas länger sind als die Breite der herzustellenden Matte. Diese beiden Hölzer werden *O* genannt. Das ein wird mittelst einer Schlinge oder eines Bandes, an beide Enden des *O* verbunden, an einen Pfosten befestigt; das andere Holz hat ein ebensolches Band, welches der auf dem Boden sitzende Weber um die Taille legt, wodurch er es in seiner Macht hat die Kettenfäden straff anzuziehen; diese Schlingen werden *Ku'u* genannt. Dem Weber zunächst sind zwei etwa 2-3 cM. breite Bambusstäbchen (*Api*) durch die Kettenfäden geschoben, so dass sie diese in eine öbere und in eine untere Lage trennen. Dan folgt ein dünner Stock (*Ka'o*) an dem, durch eine fortlaufende Fadenschlinge (*U'a*), die untere Kettenlage befestigt ist, so dass, wenn das Stöckchen gehoben wird, die untere Kettenlage über die

---

[29] Otis T. Mason. A Primitive Frame for Weaving Narrow Fabrics. U. S. Nat. Mus., 1899, p. 492.

öbere gehoben wird, und man dann das Schiffchen (*Si'ia*) mit dem Einschlagfaden (*Oao si'ia*) von rechts oder links hindurch stecken kann. Hinter dem *Ka'o* folgt ein ziemlich dicker Holzstab, manchmal auch ein dickes Stück Bambusrohr (*Porogu*) welches die Kette trennt und mit dem *Ka'o* zusammen dazu dient, die Kettenschichten abwechselnd zu heben und zu senken. Nach dem *Porogu* folgen abermals Zwei schmale *Api* wei zu Anfang. Zu dem Webeapparat gehört ferner noch ein schwertartiges Instrument (*Laga*) welches der Weber in der rechten Hand hält und damit die Kettenfäden trennt so dass er das Schiffchen bequem durchschieben kann, ferner auch um damit durchgeschobenen Einschlagfaden fest an die vorhergehenden anzudrücken.

Die Herstellung der Kette erfolgt nun folgendenmassen. Die einzelnen Theile des Apparates werden theils in den Fussboden der Hütte fest eingesteckt, theils von Gehilfen in Position gehalten. Zunächst schlagt man in den Fussboden die zwei *O* fest ein, etwas weiter aus einander, als die Hälfte der Länge der herzustellenden Matte betragt; manchmal nimmt man statt der *O* auch zwei dickere Stöcke und ersetzt sie später durch die *O*. Von unten anfangend legt man nun den Faden um diese Stäbe, schiebt aber zugleich die übrigen Theile des Apparats mit hinein, nämlich die vier *Api* (je zwei), den *Kao* und den *Porogu:* der *Kao* wird gewöhnlich auch in den Fussboden eingeschlagen, die übrigen Theile von Gehilfen festgehelten. Der Faden wird nun so umgelegt dass er abwechselnd über oder unter den *Api* und dem *Porogu* läuft, wodurch die Kette in zwei Lagen getrennt erhalten bleibt.

Höchst sinnreich ist nun die Anordnung wodurch bewirkt wird, das man die untere Kettenlage abwechselnd über die öbere heben und darunter senken kann. Dies wird bewirkt durch den dicken Stab *Porogu* und das Stäbchen *Ka'o* mit den Schleifen *U'a*. Alle Kettenfäden laufen unter dem Stab *Ka'o* fort, jeder Zweite Kettenfäden wird durch eine lose Schlinge an den *Ka'o* befestigt, so dass der Weber es in seiner Macht hat durch Heben des *Ka'o* die untere Kettenschicht über die öbere zu heben. Der Weber setzt sich auf den Fussboden und spannt die Kettenfäden wie oben beschrieben an. Ihm zunächst liegen die beiden schmalen Latten *Api* die an beiden Enden durch einen Faden mit einander verbunden sind. Er fasst nun mit der einen Hand, den Stab *Ka'o* und hebt denselben, wodurch die untere Kettenlage über die öbere empor gehoben wird, nun steckt er das breite, dünne und sehr glatte Schwert, *Laga*, eurch die entstandene öbere und entere Schicht und dreht dasselbe um, so dass die Kanten nach oben und unten stehen, nun schiebt er das Schiffchen mit dem Einschlagfaden durch, legt das Schwert flach und schlägt den Faden leise, an worauf er das Schwert herauszieht. Jetzt schiebt er den *Porogu* etwas von sich ab, ebenso den *Ka'o* wodurch er bewirkt dass die frühere obere Kettenlage die untere wird; das Schwert wird wieder durchgesteckt, ebenso das Schiffchen, und der Einschlagfaden angetrieben, *Porogu* und *Ka'o* schiebt der Weber nun an sich heran, hebt den *Ka'o* so dass die Kettenlage wieder nach oben kommt und auf diese Weise geht es nun fort bis die Matte fertig ist. Ein geschickter Weber kann in drei bis vier Arbeitstagen, jeden von Sonnenaufgang bis Mittag gerechnet, eine, Weibermatte fertig stellen.

By arranging the warp threads of different colors longitudinal bands were formed, and by varying the color of the filling on the shuttle transverse stripes were produced; the former were more common. Twills or other fancy patterns could be introduced by increasing the number of harnesses or by raising, instead of alternate threads, two, three or more adjacent ones. This loom gave opportunity for decorative weaves that were early discovered, and some of the results on the mats of the Carolines used as women's dresses are shown in Fig. 97.

Both hibiscus and banana fibre were used in this mat weaving, as may be seen in the list of mats in this Museum given below. There are specimens of the same pattern in hibiscus from Guam and the Gilbert Ids., and if we did not know they were made in both places it would be easy to imagine their transport as merchandise for

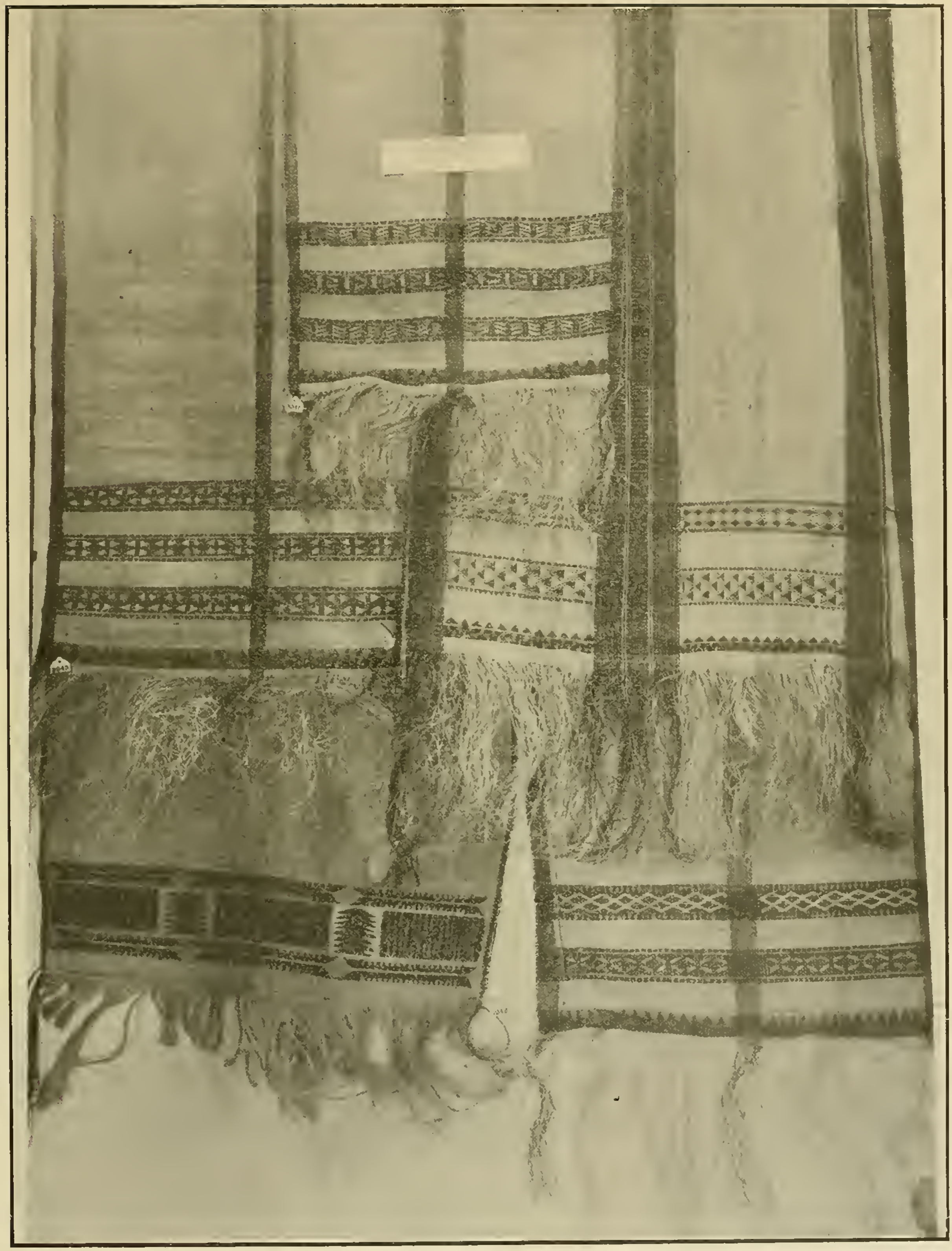


FIG. 97. MATS OF BANANA FIBRE, CAROLINE ISLANDS.

barter from one group to the other. Of the finer banana mats we have specimens from Ruk in the Carolines, Santa Cruz in the New Hebrides, and Niuë. The Santa Cruz mats are remarkably well made and tastefully decorated, and are sometimes narrow and long, with pleats and tufts for additional ornament. The beauty and durability of these banana woven mats are so marked that it is surprising that a trade to foreign countries has not been developed. I do not know what the condition of the native manufacture may be at present: perhaps, like so many good things of Pacific art, they have passed by to give place to the cheap calico that civilization has brought upon the islands.

The Tol.—Besides the loom just mentioned, the people of Kusaie in the Caroline Islands have another contrivance, by no means an orthodox loom, but still a "webstuhl," as our German friends might call it. To begin with, the writer must again confess he has never seen the instrument used, nor has got any intelligible information from any one who has, and in saying this he would disclaim any intention to speak disrespectfully of the little machine or of the intelligence of those who would have enlightened him, if possible: it is simply in apology for not handing on in these pages some intelligible explanation of its working habits. The machine, as will be seen from Fig. 98, is a biped with a long straight body, on top of which are inserted loosely certain pegs, around which are wound threads of banana fibre colored to suit the work in hand. Other spools of this fibre are at hand, if we can dignify a mere length of bambu, around which the thread is wound, with the name of spool. Then there is a frame which may possibly serve as the harness in an ordinary loom; there are shuttles of good form, and battens of considerable weight to drive home the woof or filling, and there are clam shells to serve as scissors. The threads, whether for the warp or woof, are of well cleaned banana fibre dyed in various colors, and in lengths of about five feet. To obtain the continuous length of thread these are neatly tied together by a double and almost invisible knot.

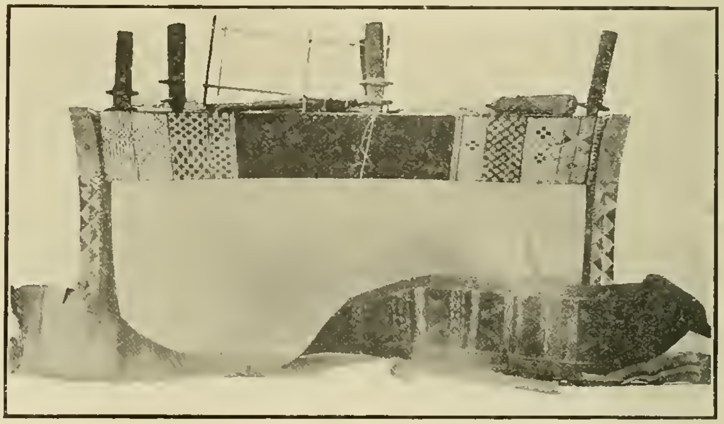


FIG. 98. FRAME FOR TOL WEAVING.

I have given the machinery, and I am forced to give the result without the intermediate processes. There are two of these "looms" in this Museum, differing in size and ornamentation, but each provided with the same attachments, and it is a subject of regret that there is not with either machine a partly finished girdle or tol. Apparently they are used exclusively for weaving the tol or girdle worn in former times by a man over his malo or waistcloth, and also for a similar but rather wider garment formerly worn by women. With both sexes the style of garment has yielded to the unpicturesque but cheaper garments of the foreign missionary or trader, and the manufacture has gone through the various stages of degradation that an obsolescent fabric always travels. When the native webster obtained from the foreign source worsted, he adulterated the banana fibre with the far less durable wool, and at the same time, or later, adopted the cheap foreign dyes. The old specimens, both of the tol and of the female dress or apron, show original and simple patterns, apparently of western (to them) origin.

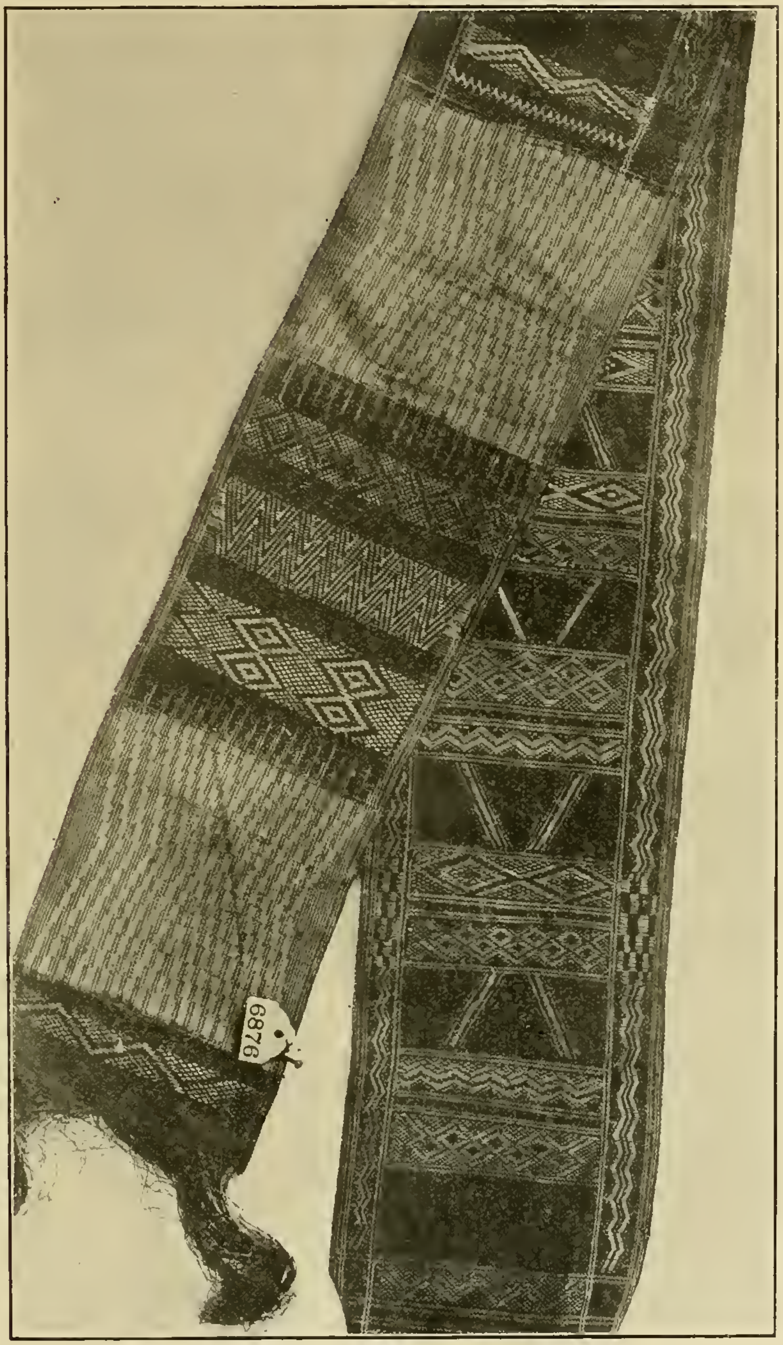


FIG. 99. TOL OF COMPLICATED PATTERN.

When we examine the fabric we find that, taking first the warp, this seldom exceeds six feet; in this the pattern is altered by tying together suitable lengths of the desired colors, and in this case the pattern is alike on both sides of the weave. Another way was also used, the common one of sinking the colored thread beneath others at intervals, and this was generally used in the transverse patterns, formed by the woof, the frame in some way facilitating the passage of the shuttle under any desired number of threads of the warp. The terminal fringe which is always found on at least one end, generally on both, if of a different color is tied to the warp threads, thread by thread. Unluckily the black dye used generally for the body of the aprons rots the fibre, and few old specimens are entirely perfect. In Fig. 100 are four specimens of this work, the first on the left being an apron in black; the others are old tols in red. The following list of those in the Museum will show the size, fineness and pattern.

LIST OF CAROLINE ISLANDS TOLS AND APRONS.

7842. 5.2 ft.×8 in.—58 to inch. Black apron from Kusaie. Ornamental portion in brown, red, black; 14 in. long at one end; at the other three yellowish stripes, one central of two strands, two lateral of one each. Fig. 100, No. 1.

6621. 6.1 ft.×4.8 in.—76 to inch. Tol from Ponape. Red, with double border of yellowish strands along each edge; ornamental end 16 in. of red, yellow, black; at other end 14 in. of yellow with seven single or double black strands. Fig. 100, No. 2.

6620. 5.6 ft.×4.5 in.—70 to inch. Tol from Ponape. Red, with seven transverse bands of yellow designs woven through, not alike on both sides. Fig. 100, No. 3.

6619. 5.4 ft.×4.5 in.—60 to inch. Tol from Ponape. Red, with borders of darker red and yellow and transverse bands woven through; end design alike on both sides. Fig. 100, No. 4.

6876. 5.5 ft.×4 in.—82 to inch. Tol from Ruk. Decoration in red, yellow, black. Fig. 99. A portion is rolled up and bound, to pass between thighs.

8799. 4.3 ft.×2.7 in.—58 to inch. Tol. Red and yellow, with nine transverse bands, all different.

6626. 5.5 ft.×4 in.—56 to inch. Tol from Ruk. Red, with yellow; longitudinal and transverse stripes coarsely embroidered with scarlet worsted.

Summary of the Basketry.—Before considering the net work of the Hawaiians, which has been so thoroughly studied by Mr. John F. G. Stokes, Curator of Polysian Ethnology in the Bishop Museum, that I have asked him to prepare the portion of this memoir relating to that handicraft, we may draw together the information we have been able to collect about the Hawaiian mats and baskets, and institute a brief comparison with similar work throughout the Pacific, although the material at our disposal is not sufficient to warrant much theorizing as to origin or relationship.

We find that the old Hawaiians made a basket (both Hinai ieie and Hinai ieie poepoe) much superior in workmanship and durability to any others made in the region under consideration; and these do not closely resemble the basketry of nations or tribes bordering on the Pacific. The Samoans made baskets of very different form, and no known specimens of their work are related to the Hawaiian baskets or could have served as prototypes. The Fijian and Micronesian baskets are closely related and show an occidental (to them) origin. The baskets of Australia are peculiar in form rather than material, and could not be mistaken by a student of basketry for those of any other country. The Solomon Islanders and New Hebrideans make baskets of mat-like consistency, quite unlike the Hawaiian, but also make genuine baskets of considerable perfection. The New Zealanders make baskets of a still different type, but their kete or satchels remind one of the satchels made by the Fijians and Gilbert Islanders, in shape, although not at all in material. It is difficult to see that Hawaii has taught other groups, or has in the least been influenced by their work. Even where the same material has been used, as in the case of pandanus leaf, the resulting baskets are of quite different forms. Even the baskets used for fish traps, when made in both countries from fern stems, differ in shape in Hawaii and New Zealand. The Samoan fish trap made of coconut roots is, it is true, not unlike the Hawaiian fern stem fish trap.

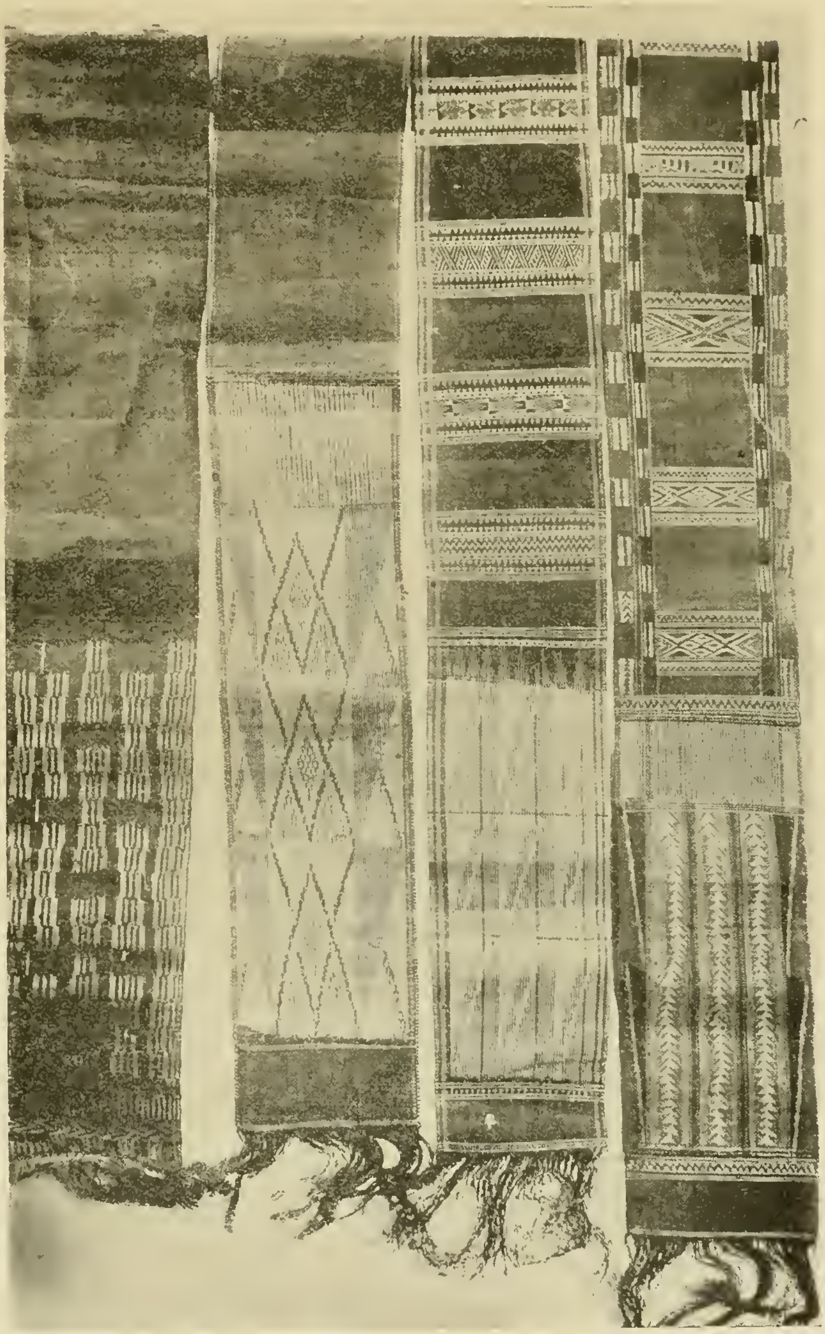


FIG. 100. APRONS AND TOLS.

All through this region the baskets, with the exception of the rude coco leaf frails, differ sufficiently from those of other countries besides differing among themselves. Generally speaking there are few forms which could advantageously be adopted by other countries, or be made articles of commerce. Like the peoples who made them, and whose wants they doubtless supplied well enough, they seem to be passing off the stage, and most of them have become even now material for museums.

With mats the case is somewhat different. Wherever on the Pacific islands the pandanus grows its leaves were used for mats, and were prepared much in the same way, to be woven in the same manner, into mats hardly differing among the groups. We can go beyond the Pacific region and find the same mats wherever we find the pandanus, but when we rise above the plain coarse mat we find more or less differentiation in the finer work. Then the material accessible, as in the case of the basket, influences the form, and we have seen by illustration that it is by no means difficult to distinguish, in most cases, the place of manufacture.

While Hawaii leads in the manufacture of baskets (in the olden time), and has produced most durable mats in the makaloa class, Hawaiian mat work cannot rank with the Micronesian fibre mats, nor perhaps with the fine mats of the Samoans. Maori mats were much more artificially made than those of the southeastern Pacific islanders: Tonga alone held a good place in the mat making industry after Samoa. In the northwest, the Solomon Islanders and the New Hebrideans were more noted for their basket work than for mats; and in New Guinea, so far as I am aware, neither mats nor baskets were notable. It is probable that the bags of netting, for which New Guinea is to be credited, took the place of baskets.

We have seen that the partial use of mats for dress was general throughout the Pacific, although only in New Zealand did the mat become the most important part of one's dress, for there the cool wet climate compelled more covering from the weather than on the tropical islands of the rest of Polynesia, where the more pliant kapa became the most important material for clothing.

Note may be made that while the universal form of pandanus mat showed little variation throughout eastern and central Polynesia, on the western islands of the region there are curious adaptations of the material unknown to their eastern neighbors. These have mostly been figured, and it will be seen that they are of rather primitive character.

Mats were articles of exchange or commerce far more than ever baskets were, and hence we find them wherever the adventurous canoes of the early voyagers touched shore; and while this fact has made it more difficult to distinguish the origin of some mats, the material being everywhere the same, it has tended on the other hand to preserve mats rather than baskets of former times in our museums, for as common articles of barter they were brought everywhere to the early European and American explorers of this ocean, and being portable were brought home.

No dates can be assigned to any of the methods used or patterns produced in Pacific basketry, nor can it be declared which branch of the Polynesian family originated or taught any especial manufacture either of basket or mat. Legends are merely indications with little or no historic value.

The study of both mats and baskets of the Pacific is far from complete, and if it were possible to make larger and broader collections, much that is interesting and also valuable would be brought to light. In all branches of basketry pertaining to our region this Museum is constantly making collections, but at present only the Hawaiian division seems fairly complete.

Hawaiian Nets and Netting. *By* JOHN F. G. STOKES, *Curator of Polynesian Ethnology in the Bishop Museum.*

AS WITH most, if not all, primitive races, the Hawaiians had a knowledge of the art of netting which they had brought to a high standard of excellence before the general influx of the foreigners. They had even gone so far as knitting, making a very complicated knot without tools. If mat making evolved the loom, then netting was the forerunner of lace making, but the natives' art had not reached this point.

Nature has been bountiful to these people in its supply of raw material for their cord, giving them the fibrous husk of the coconut, the sedge *ahuawa* (*Cyperus lævigatus*), and the bast fibres of the *hau* (*Paritium tiliaceum*), *waoke* (*Broussonetia papyrifera*), and, most valuable of all, *oloná* (*Touchardia latifolia*), which is very strong, light and durable. In addition to the foregoing, several grasses were pressed into service for braiding into ropes for house building. And human-like, discontented with much, or perhaps pandering to the love of ornamentation, or, it may be—let us allow for higher sentiments—wishing to keep in memory dear friends, human hair was frequently braided or twisted into patterns in many of their ornaments. In more modern times, horsehair has been spun and used with other cord in some of the *koko puupuu.*

The preparation of the coir was simple, merely requiring the separation of the fibres of the husk, and, when spun or braided into cord, was highly esteemed for the lashing of canoe outriggers on account of its presumed durability in salt water. For fish nets it was seldom used, not being as strong nor as pliable as the more favored oloná, but for the koko it was applicable and used extensively as well as for the cordings attached to certain gourd vessels. Coir would be prepared, twisted and worked into a koko in the same day. This was no doubt necessary, as the fibres, when dry, are very stiff and would be difficult to twist into the close meshes of some of the nettings in which coir is found.

Ahuawa, common on the banks of the taro ponds, was prepared by drawing the freshly plucked stem between two rounded sticks tightly compressed for the purpose of removing the juices, and heckling, and then spinning the fresh fibre into cord for the koko. This fibre was also used for tying on the thatch to the grass house.

The hau, waoke and oloná were prepared similarly, being partly macerated in running water and scraped with a piece of pearl shell or turtle rib.[30] This would be a process of a few days.

The waoke, used so largely in the manufacture of *kapa*, was restricted in cord to the making of koko and ornamental rope. The filaments are soft, clinging, and of only moderate length, and while thus well suited for bark cloth they would not last in such fabric as fish net.

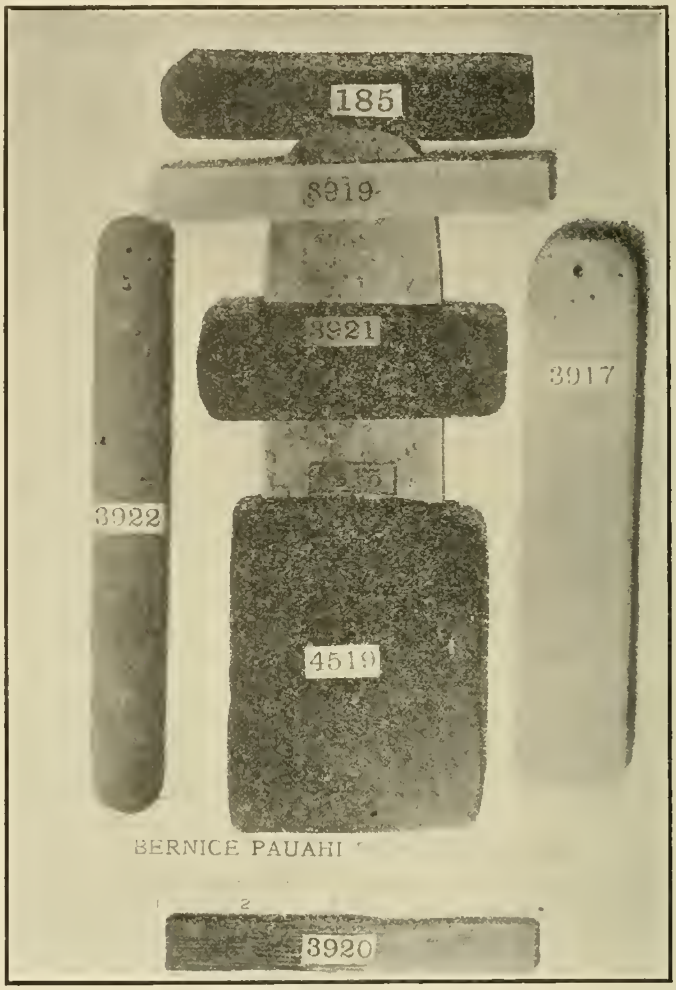


FIG. 101. MESH GAUGES.

The hau, a hard fibre, had employment as heavy rope mainly, but rarely in fish netting or koko, while the oloná was the best used material for fishing lines and nets, also occasionally finding its way into the better class koko.

The grasses were braided with little or no preparation, the work being done while the material was green. The spinning of cord, *hilo*, was always done on the bare thigh by women, the native terms for the process being *hoaha* for coir and *hoaho* for other cords. Men generally attended to the braiding.

[30] Memoirs B. P. Bishop Museum, Vol. 1, p. 50, fig. 43.

The tools used were, the mesh stick or gauge (Fig. 101) and the shuttle (Fig. 102), made of whale ivory and rib, human and quadruped bone, tortoise shell, wood or bambu.

The gauge, *haha*, is a short, thin, flat implement of varying widths. In describing a net, the native put his fingers into the *maka* or mesh, and if the first finger filled the space, the mesh was *makahi*; if three fingers were needed, then the mesh was *makolu*, etc. For sizes between, the words *oene* or *oa* were added to the name of the smaller mesh. The following is a table prepared for the writer by a native fisherman, with the sizes approximated:

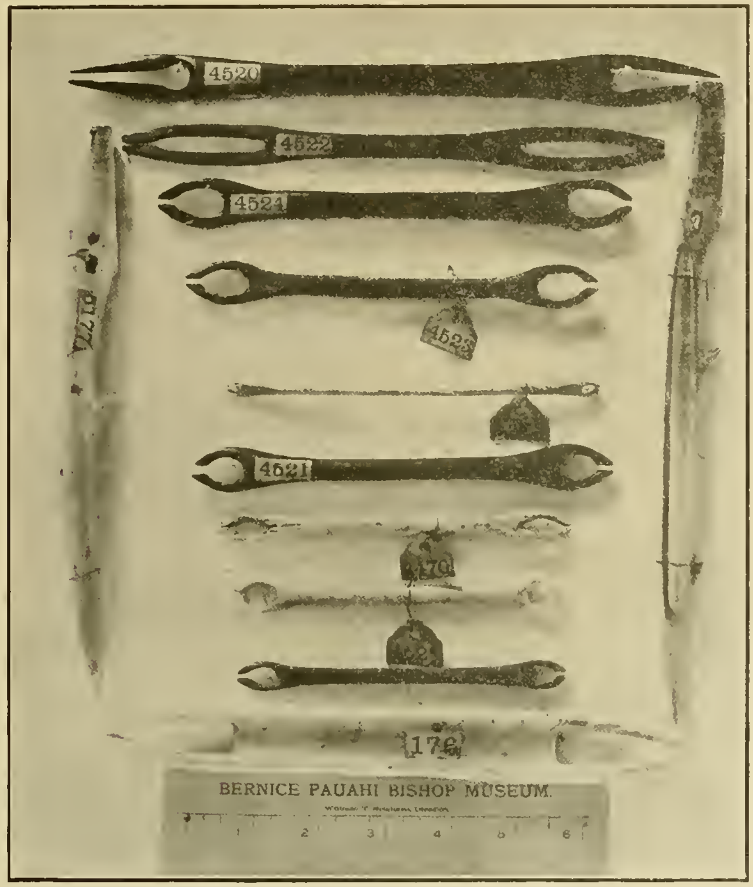


FIG. 102. SHUTTLES.

Nae, ¼ in.
Nukunukuaula, ½ in.
Makahi,[31] 1 in.
Makahi oene, 1½ in.
Malua, 2 in.
Malua oa, 2½ in.
Makolu, 3 in.
Makolu oa, 3½ in.
Maha, 4 in.
Mahae, 4 in. and upwards.
Malewa, 7 in. and upwards.

The shuttle, *hia*, is found in two distinct shapes. The more highly esteemed was the form, world wide in adoption, composed of a shaft with an eye at each end, the outer edge of which was cut away to admit the cord. The shank of this is round in cross section and diminishes toward the middle, making a more effective tool than that with the flattened or grooved shank, for the native implement allowing of a cylindrical winding could pass more cord through a given mesh. The natives were always very careful when filling their shuttles, passing the cord straight up and down along the shank, then winding on one side crossing the cord and repeating on the other, to attain the cylindrical form.

The other form, *kioe*, better known as a net mender, is a round stick of wood about one-third of an inch in diameter and six inches long. The stick for about one-third of its length has been cut down, leaving a shoulder, and tapered to a blunt point (Fig. 103, A). There are two specimens in a loan collection in the Museum which are exceptional, having the butt only one-third the total length (Fig. 103, B). To fill this style of needle, two half hitches were passed around the tapered end and a loop made around the fingers of the hand holding the tool, as shown in the same figure. For very fine nets a *niao*, piece of the midrib of a coconut leaf, was substituted for this form.

---

[31] Contraction for maka, and the numerals akahi, alua, akolu and aha. The enclitic *e* on mahae means other, or another. The names *maha* and *malewa* do not seem to be generally known among the natives.

In making the large-meshed, coarse nets for sharks or turtle, neither shuttle nor mesh stick was generally resorted to. The cord was wound over the hand and elbow for several turns, the hank thus formed doubled and wound with the rest of the cord until a pear-shaped ball was made. The cord could then be drawn from the inside through the point of the ball, which retained its shape until expended. The cord in this form took the place of a shuttle, while the spacing was roughly done by the hand. A similar winding, but more spherical, was in vogue for the fishing lines.

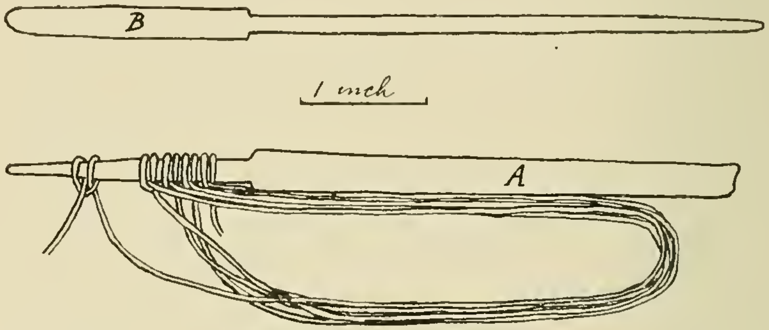


FIG. 103. NET-MENDERS.

For fastening two nets together temporarily, there was a needle of bone or wood with an eye towards the end. The needle and line were merely run through the opposing meshes and the nets thus drawn together. A similar needle was also used for sewing the top sheet of kapa to those beneath. Frequently when fishing it was necessary to join two nets below the water, for which purpose this needle or the net-mender was requisitioned, but native fishermen have told the writer that the quickest and simplest way was to dive down and tie the ends with split stems of the *ki* leaf (*Cordyline terminalis*).

In Fig. 102 are shown three specimens, Nos. 176, 5177 and 5178, which certainly do not owe their origin to Hawaiian hands. The native mind is a peculiar one in regard to specimens of former arts. Any implement a man in his childhood had seen his father use is looked upon in later years as very ancient indeed, and is honestly believed by him to have belonged in succession to his forbears far down in the misty flights of time. This impression of the writer was not entirely gathered from observation of the natives bringing specimens for sale to the Museum. When articles were so offered, the natives almost always claimed that such were used by or in the possession of Kamehameha the Great, with the mistaken idea of securing a higher price.

They were right in their contention, though they had perhaps forgotten that their grandfathers admitted that the king owned the heavens and the earth, the sky and the sea and all therein contained.

Specimen No. 176 was purchased by an antiquarian collector, of good repute, as a Hawaiian shuttle, and with it came the following interesting history:

> "Made of the shinbone of Kuliakalanaia, an expert fisherman of Kohala, Hawaii. He was also a man without hair on his limbs. For these reasons his bones were wanted for fish hooks, etc., and he was therefore murdered for his bones. Lualauoho, an aipuupuu of Kamakahelei, secured the inner bone of the right leg as his share of the spoil. From it he made this ka [hia], tatting shuttle, which he very greatly prized on account of the good luck it brought his nets. On his death it passed to his son Kama who was also an aipuupuu of the same chief. Kama died at Hoopuloa, April 10, 1886, over a hundred years old, the wealthiest native in Kona, when this ka was left to his grandson G. L. Walia Kealiikuli, who resold it February 12, 1887."

That such a value was set on implements of human bone was entirely correct, and there is little doubt in the writer's mind that the last native possessor believed the history submitted; but on finding the material to be ivory and referring a sketch of it to Professor O. T. Mason, that gentleman pronounced it an "Eskimo netting needle." A comparison with shuttles figured in Nelson's work on "The Eskimo About Bering Strait"[32] will confirm this. From about 1837 until a few decades ago the Hawaiian Islands were the wintering quarters for the whaling fleet operating off the coast of Alaska and in the Bering Sea, and with it many native seamen shipped for the summer cruise.

The other specimens, Nos. 5177 and 5178 were acquired in part of the collection of the late Queen Emma labelled "Ivory tools for netting koko and ieie baskets." They were shown to several of the older natives, and while some did not recognize them, others claimed them to be Hawaiian implements but were not familiar with their uses. Each specimen consists of two pieces: the larger is a slightly curved implement with the outer arc notched at the butt end, smooth, rounded and decreasing in thickness until the sharp point is reached: on the inner side, from the point to the first barb, is a knife edge; from the first to the second barb, and from the second for about one-quarter the length it is curved, smooth and rounded, the remainder being straight and plane. About one-quarter the length from the butt end is a rectangular hole. This was identified by Professor Mason from a sketch as the side prong of a Hudson Bay spear point; and, since Nelson reports a similar one from St. Lawrence Island,[33] these specimens no doubt reached Bering Strait through trade and by the same means the native sailors acquired them and brought them here. The smaller implements are somewhat similar to the marlinspikes used in netting and figured in the same paper from Cape Nome,[34] and each implement is provided with the spur-like projection mentioned therein.

---

[32] Eighteenth Annual Report of the Bureau of American Ethnology, pl. lxxiii.

[33] Pages 149 and 150, fig. 42 (8), of the same work.

[34] Page 193, pl. lxxii, figs. 19 and 20 of the same work.

There are four long clumsy shuttles made of pine in the Museum's collections, used by natives, averaging about 13 inches long. The shafts of these are rounded, and the points of the eyes thick and square. In each, 2.5 in. from an end, is inlaid a small piece of lead. They are certainly not Hawaiian, and the locality of their origin is not at present known to the writer.

Doubt has also arisen concerning the origin of some of the gauges, for the native mesh stick was very thin, seldom or never thicker than one-tenth of an inch, and No. 3917 (Fig. 101) is over .3 in. thick. However, the characteristics of Hawaiian mesh sticks are not strong enough for fully satisfactory identification. Specimen No. 3915 was at one time 4.8 in. longer, and from the end of it No. 3916 has been sawn or cut off, as certain marks on the two specimens testify, and used separately. Probably No. 3919 came from the same source. The total length of the original specimen, 12 inches, must have made a very awkward gauge for use.

The following is a list of Hawaiian netting tools in the Museum:—

Gauges.—Haha.

185. Tortoise shell. Length 4.2, width .98 inches.
3915. Whale rib. Length 7.2, width 2.1 in.
3916. Whale rib. Length 4.8, width .8 to 1.1 in.
3917. Whale rib. Length 6.2, width 1.3 in. Very thick.
3918. Bone, human(?). Length 3.6, width .9 in. Rather thick, edges lightly and evenly serrated.
3919. Whale rib. Length 4.5, width .6 in.
3920. Bambu. Length 4.2, width .6 in.
3921. Tortoise shell. Length 3.5, width 1.2 to 1.3 in.
3922. Tortoise shell. Length 6.8, width .85 in.
4519. Tortoise shell. Length 3.8, width 2.9 in.
6795. Naio(?) wood (*Myoporum sandvicense*). Length 5.5, width 1.1 to 1.3 in.
9033. Tortoise shell. Length 2.9, width .5 in.
9034. Tortoise shell. Length 4.3, width .88 to .98 in.
9035. Tortoise shell. Length 4.2, width 1.2 in.
L 183. Tortoise shell. Length 3.2, width 1 in.
L 184. Tortoise shell. Length 3.4, width 1.25 in.

Shuttles.—Hia.

176. Walrus tusk. Length 8.8 in. Originally Eskimo.
4470. Whale rib. Length 5.8 in.
4471. Whale rib. Length 5.6 in. Very narrow.
4520. Kauila wood (*Alphitonia excelsa*). Length 10 in.
4521. Kauila wood. Length 6.3 in.
4522. Bambu. Length 8.2 in.

4523. Naio. Length 6.3 in.
4524. Kauila. Length 7.2 in.
4525. Bone, human(?). Length 5.1 in.
4526. Pine. Length 12.8 in. Not originally Hawaiian.
4527. Pine. Length 12.8 in. Not originally Hawaiian.
4528. Pine. Length 12.9 in. Not originally Hawaiian.
4529. Pine. Length 13 in. Not originally Hawaiian.
6793. Naio. Length 6.4 in. One eye broken.
9030. Kauila. Length 5.3 in.
9031. Naio. Length 5.3 in.
9032. Naio. Length 4.9 in.
L 179. Kauila. Length 6.7 in.
L 180. Kauila. Length 7 in.
L 181. Kauila. Length 5.6 in.
L 182. Kauila. Length 7.9 in.

Net-menders.—Kioe.

9036. Wood. Length 5.6 in., of point 1.8 in.
9037. Wood. Length 5.7 in., of point 2 in.
9038. Wood. Length 5.8 in., of point 1.9 in.
9039. Wood. Length 5.9 in., of point 2.1 in.
9040. Wood. Length 6 in., of point 2.2 in.
9041. Wood. Length 6.2 in., of point 2.4 in.
9042. Wood. Length 6.45 in., of point 2.25 in.
9043. Wood. Length 6.55 in., of point 2.2 in.
9044. Wood. Length 6.6 in., of point 2.3 in.
9045. Wood. Length 6.65 in., of point 2.2 in.
9046. Wood. Length 6.6 in., of point 2.15 in.
9047. Wood. Length 6.9 in., of point 2.4 in.
9048. Wood. Length 7.2 in., of point 2.3 in.
L 380. Wood. Length 10.2 in., of point 7.3 in.
L 381. Wood. Length 6 in., of point 1.8 in.
L 382. Wood. Length 6.1 in., of point 4.1 in. (Fig. 103, B.)
L 383. Wood. Length 5.6 in., of point 1.7 in.
L 178. Wood. (1) Length 5.9 in., of point 1.5 in.; (2) length 5.9 in., of point 1.8 in.; (3) length 5.9 in., of point 1.8 in.; (4) length 5.9 in., of point 1.9 in.; (5) length 6.1 in., of point 1.8 in.; (6) length 6.5 in., of point 1.9 in.

Hawaiian nettings can be almost as conveniently classified by their use as by their appearance, and in this article two main divisions will be considered, the bag or netting surrounding a utensil for the purpose of carrying, and the fabric similar to that known as fish net.

Netted bags include the koko or detachable net used to carry or suspend the *umeke*, wooden or gourd bowls containing food or clothing (Figs. 104 and 105), and the cord permanently attached to various gourd utensils as a means of fastening a handle thereto, generally known by the name of the cord, *aha* (Figs. 106 and 107).

Koko.—The koko is a bag, of cord netted or knitted, in the shape, when suspended, of an inverted hemisphere superposed by an elongate cone. In technique it was divided into three parts, Fig. 108, the first, following the order of the work, being *piko*=navel, beginning, *kumu*=root, or *hoomaka*=starting place. The term *poaha* has been applied to this part, and many of the piko when completed would be large enough to act as a poaha. The latter was a ring of rope or bound pandanus leaves, placed on the ground, on which the rounded bottom of the umeke would rest. The second or main part was often referred to as koko, but there was a technical word, *hanai*, to represent it;[35] the word *opu*=belly, any swelling surface, was also used for this part. The third, called *kakai* or *alihi*, was a cord interlooped, Fig. 113, with or knotted, Figs. 114 and 115, to the outer edge of the hanai in two series. The names kakai and alihi seem to have been used as frequently for the suspending cords of the koko, but since the name alihi is also used for the head and foot ropes of the fishing nets, it might be better to retain the name kakai for the koko. Each series was bound in the middle (ultimately the top) by a single smooth winding, and sometimes by half hitches, to make a *pu* (handle), and into these pu was the end of the *auamo*, bearing stick, thrust to carry the load, Fig. 153. The auamo, or *aumaka*, is a stick of hard heavy wood, generally *kauila* (*Alphitonia excelsa*), about six feet long and borne across the shoulder, Fig. 109; the ends drop a little below the middle and are either notched or neatly carved to hold the kakai, Fig. 153. For protection of food against animals, the koko was suspended from a wooden hook, *kilou*,[36] attached to the ridgepole of the hut, or from a crossbar shaped like a canoe and notched around the edges; this implement was called *oleole*[37] or *haka*, and was placed on the top of a pole set in the ground.

The work of making koko was done by one of the *kahu* or body servants of the alii. Frequently a kahu well skilled in such arts was in the service of the king, who, to show favor to his friends, would place the skill of the kahu at their disposal. Another source of manufacture was the common people, who brought great numbers of koko to the alii in payment of taxes, and after the best had been selected by the chief and his friends, the poor ones might return to the commoner.

Since this essay is intended to place on record this part of the natives' art now forgotten, and the usefulness of which has entirely ceased, and also to give a catalogue

---

[35] Lorrin Andrews, A Dictionary of the Hawaiian Language. Honolulu, 1865.

[36] Edge-Partington and Heape: Eth. Album of Pacific Ids., Vol. III, Pl. XV, No. 1.

[37] Ibid., Nos. 2 and 3.

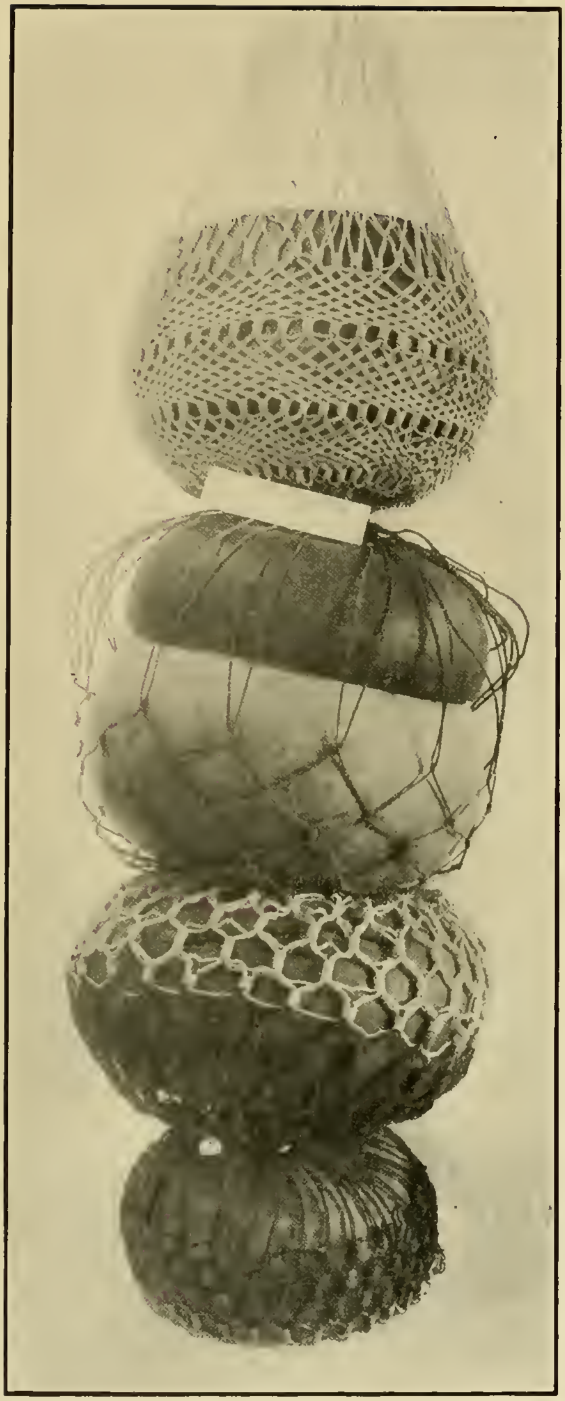


FIG. 104.

a. Koko puupuu, Hanai E.
b. Koko pualu, Hanai A.
c. Koko puupuu, Hanai D.
d. Koko puupuu, Hanai D.

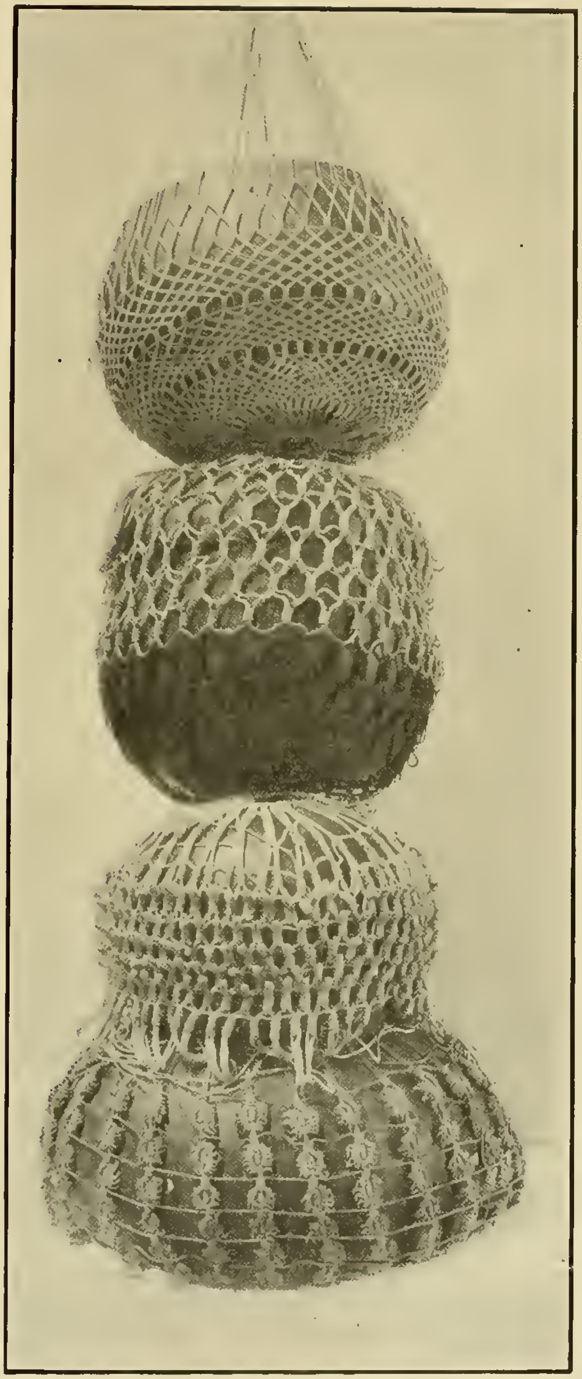


FIG. 105.

a. Koko puupuu, Hanai E.
b. Koko puupuu, Hanai D.
c. Koko puupuu, Hanai G.
d. Koko puupuu, Hanai K.

of what is now available in this Museum to students of ethnology, greater attention has perhaps been given to detail than a general description would call for. It has been necessary to make a liberal use of the native names, which at the present day are liable to be inaccurately applied. And again it has been found that sometimes in different islands of the group one name may be employed for different articles, and dissimilar names for the same thing.

Piko.—The piko is a ring of cord at the bottom of the koko, attached to which, by loops, knots or half hitches, is a row or circle of loops on which the hanai is begun. The habitual position of natives when doing all such work was sitting on the ground, with one leg over the other and the upper foot projecting slightly. From the big toe of this foot the cord was stretched, and the diagrams of the technique herein have been drawn as if in the same position, unless specially mentioned.

Of piko, there were observed fourteen forms in specimens obtainable, and in the following descriptions of the modes of operation the arrow heads point towards the shuttle or ball of cord.

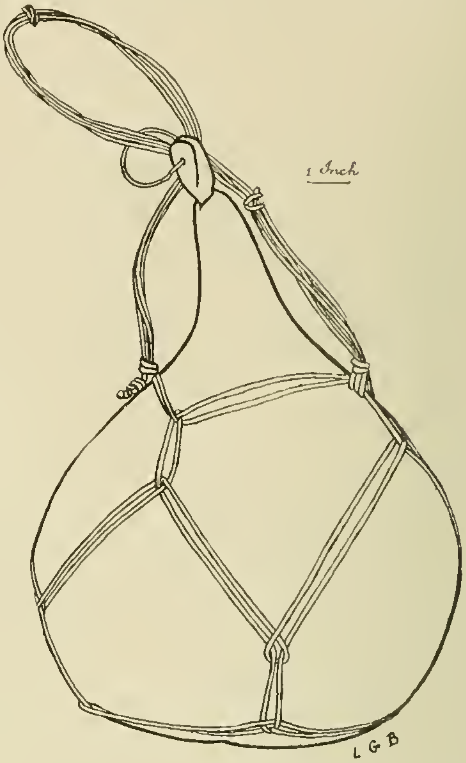


FIG. 106. HUEWAI. GOURD WATER BOTTLE.

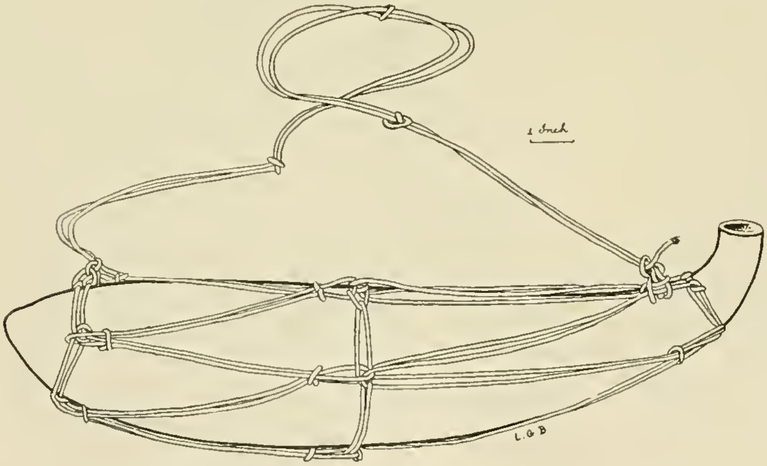


FIG. 107. OLOWAI. GOURD WATER BOTTLE FOR CANOE.

Piko A (Figs. 110 and 111).—A piece of cord is first knotted into a ring with the loose ends closely severed. In the first figure, at the point *b* the shuttle is passed over and under the ring, over the free end of the cord *a*, under and over the ring and back through the loop along *a*. At *c* a simple knot is tied on *a* and the half hitches at *b* are repeated at *b′* leaving a loop at *d*. The loops (from 6 to 12) are formed in this manner and completed by the return cord *e* making a knot with *a* at *f*. The work from this point is part of the hanai.

This is Piko A in its simplest form, and in the second figure a variation is shown where the shuttle cord, after tying at *b*, makes a different knot with *a* at *c*, the details of which are shown at *c′*. All the knots at *c* are tied similarly to *c′*, and at *c″* the order of tying is merely reversed. The return cord *e* knots with *a* at *f* as shown.

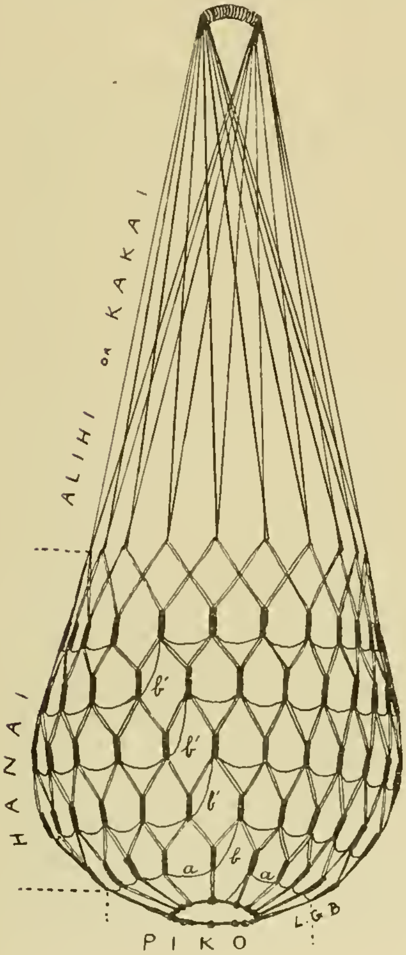


FIG. 108. KOKO PUUPUU.

PIKO B (Fig. 112) is as in Piko A as far as *c* where the shuttle cord is knotted simply, thus leaving a loop, through which the loop *d* is passed. Then the shuttle is run twice round the loop *c*, and back through the two loops thus made. This knot is the same as a fisherman's knot with a double turn. Piko B differs from the former in that an additional loop *d* is added to each knotted loop *c*.

PIKO C (Fig. 114).—A simpler form than the following piko. In this the cord is twice looped, and the free end *b* passed under the shuttle cord *a* and around *a* and *c*. The loop *d* is left and the free end knotted around the base of the loop, thus fastening the ring. The shuttle is then sent around the ring at *f*, when the process of the first knot at *c* is repeated reversed.

PIKO D (Fig. 116).—A double ring being made, the free end is passed over the shuttle cord, under the other ring cord and back over the shuttle cord, following which a half hitch is made around the ring and the knot at *b* completed, Diag. 1. Then, Diag. 2, three loops are made through the ring at *d*, the shuttle returning at *e* and being sent around the loops and cord *a* three times and through the loops thus formed. The knot at *h*, Diag. 3, is thus made, and the cord *f* carried to the next point *g* on the ring, where the last described knot is repeated.

PIKO E (Figs. 117 and 118).—In the samples examined, a double ring was made, with the free end *a*, Diag. 1, Fig. 117, passing under the shuttle cord *d* and over the middle cord *b*. Then, Diag. 2, *a* is looped, passed through the ring at *b* and knotted simply to itself at *c′*, looped again and a fisherman's knot with two turns run around the part of the ring at *b*. This process results in the knot at *h*, Fig. 118. Then the shuttle cord *d*, after tying at *c″*, continues, as *f f*, the work of the piko, which is complete when *f* joins the free end at *i* and begins the hanai as *f′*. This piko in principle is the same as the previous two, but the compression of the ring at the four points gives a very different effect.

The five foregoing piko were all made with the shuttle and attached to netted hanai. They were, too, more often used in the koko pualu than in the koko puupuu.

Piko F (Figs. 119 to 122) was found to be the most common in the koko puupuu, and this and the following styles were made from cord on a ball, not a shuttle, and were attached to the knitted hanai. Four methods of forming the ring in this piko are illustrated in Fig. 119. Diagram 1 shows the end cord *a* looped and tied with the ball cord, forming *b*. Then the ball cord is looped at *g*, passed under *b* at *c* and through the loop *g* at *d*; or, a half hitch is formed and slipped over *b*, following which the ball is passed around *b* at *c*, the loop *f* passed through *e d* and the ball carried round *b* to the next point. In Diagram 2 the cord is bent at *b* and the ball cord carried round the end cord *a* at *c* and the loop *f* made as before. In the next diagram, a slip knot is tied to the end cord *a* at *d*, whence the loops *f*, etc., are formed as usual. The loops of the piko in these three diagrams continue along *b* until the piko is of the requisite size, when the end cord *a* is passed through the end of the loop *b*, knotted or twisted and concealed, as also in Diagram 4, in the first knot of the hanai. In Diagram 4 a double ring is made and the ball cord wound once around the end cord *a* at *b*, and the loop *f* proceeded with as before; the cord *a* is left free to enlarge or decrease the ring during the work. The appearance of Piko F is shown, obverse side in Fig. 120, and reverse side in Fig. 121. In this piko and some of those following, the end cord *a* after being attached to *b* is sometimes wound around the bases of the outer loops *f* once or twice for ornamental effect. Fig. 122 shows Piko F with the end cord run twice around the loops.

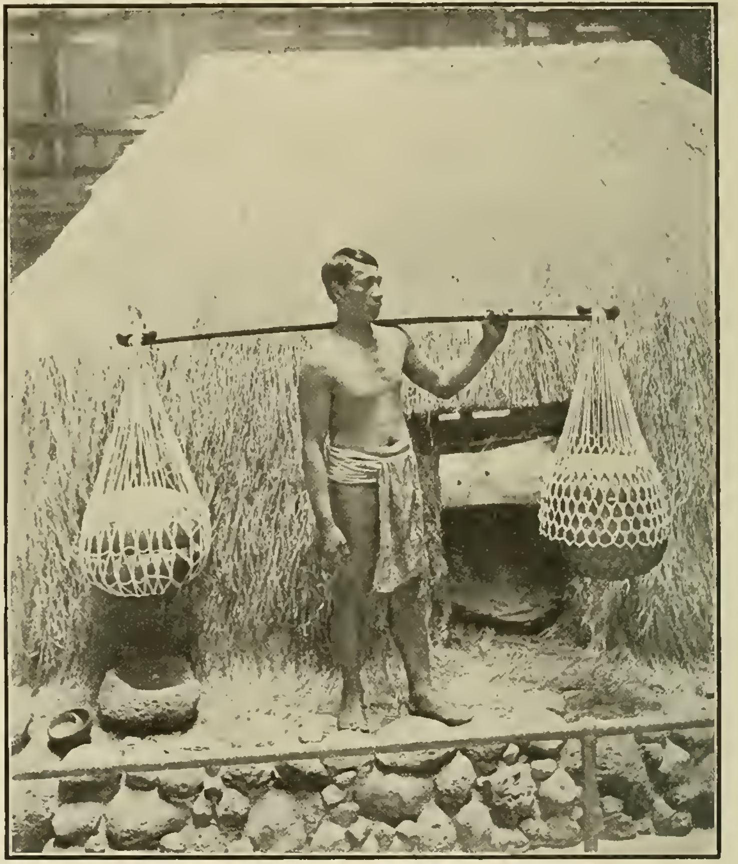


FIG. 109. NATIVE WITH AUAMO OR BEARING STICK.

Piko G (Fig. 123) is shown with a quadrupled cord forming the ring. After doubling the cord twice, the ball cord is tied with a simple knot around *c* and *a* at *e*, and leaving a loop at *f*, two half hitches are run around or slipped over *b* and *d* as shown at *g*, *h* and *j*. In the specimen figured the ring was joined by passing *b* and *d* through *c* and tying *a* to the latter. Then the loops *b* and *d* together were used for the first knot of the hanai.

Piko H (Fig. 124).—After being looped at *b* and tied at *c*, two half hitches are taken around the base of *b* leaving a loop at *d*. Then the ball cord is passed behind and around *b* (see *f*) and the loop *g* slipped through the loop thus made. At *h*, the last loop of the piko, an additional half hitch is slipped over *b* after the loop has been made.

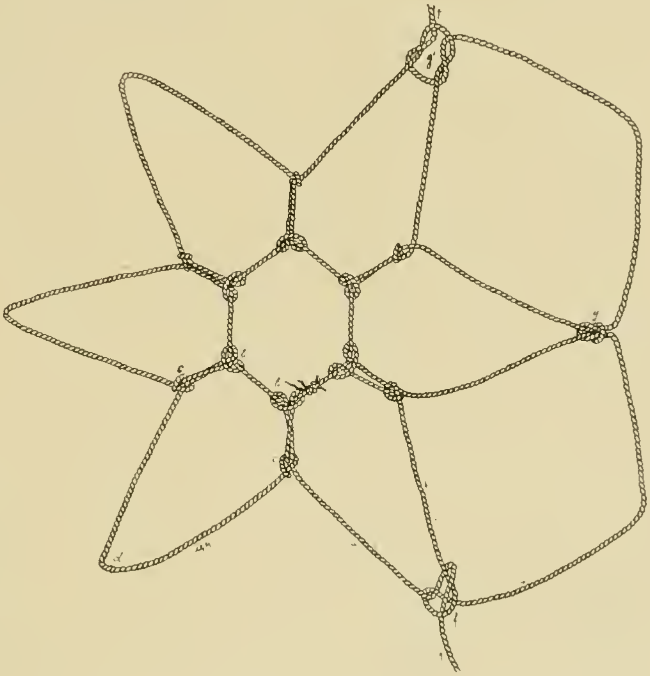


FIG. 110. PIKO A, HANAI C.

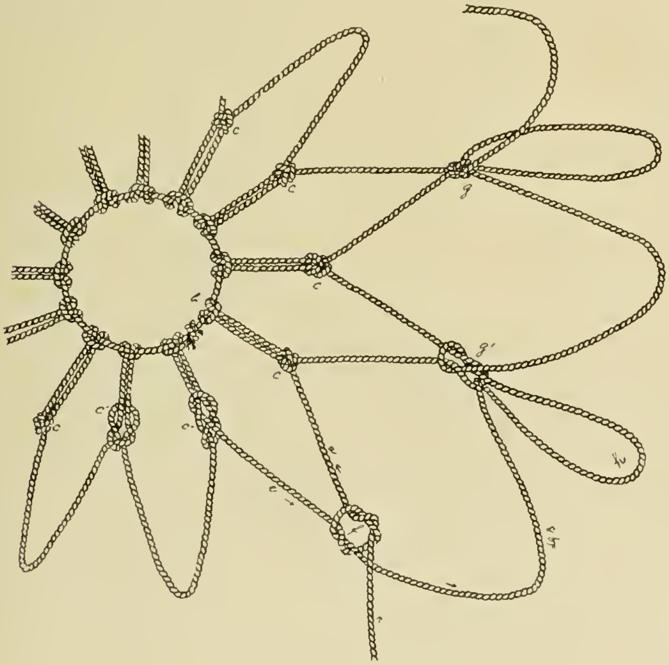


FIG. 111. PIKO A, HANAI C.

Piko J (Figs. 125 and 126) is simpler than F and one step further on than H. In the specimen taken as an example and figured, Fig. 125, the piko could have been as easily made with one piece of cord, by running *y* on as *a*, as with two. A detached cord is bent double at *z*. Then the ball cord is passed around *x* and *y* and over the free end *a*, to begin the work, and back under *x* and *y*. Following this a loop is made (see *d*), twisted round and slipped through the loop *b* thus left, and the work continued with the ball cord *c*. In the example figured, the ring was joined by passing *x* through *z* and tying with *y*, when *x* and *y* were concealed in the first hanai knot. Fig. 126 has the end cord wound once around the base of the loops as referred to in the paragraph on Piko F.

Piko K (Fig. 127).—This is similar in construction to the last, but with the outer loops far apart, and the spaces on the ring between wound with the ball cord. In Diagram 1 the cord has been doubled, leaving a loop at *b*. Then the ball cord is looped at *c* and at *d*, the latter being passed around *a* and through *c*, and drawn taut. The ball cord is tightly wound around the bend of *b* for several turns and two loops formed, the second being passed under *b* and through the first. Diagram 2 shows the method of fastening the ring, which being done, the ball cord *c* and end cord *a* are combined to make the first knot of the hanai. This piko consists of from fifteen to thirty loops, and is generally very large in diameter.

Piko L (Fig. 128).—A triple ring is made by doubling the end cord at *b* over the ball cord *a* and running the former twice around, Diag. 1. Then the end cord *c* is wound round *b* once and the cords of the ring for about one-quarter its circumference, and is passed back and forth through the ring to form the loops *o o*, Diag. 2; after the last turn *c* this cord is wound four times around the bases of *o o*, Diag. 3, passed through the windings *m* and around the cords of the ring at *f* and the winding on the ring continued at *g*. It is probable that the piko in the specimen examined was made with a shuttle or a small ball of cord in addition to the large ball, for the amount of this end cord is considerable. Then the ball cord *a* is looped three times, the bends being doubled over *b* (making six loops at *p p*) and bound with four half hitches by *a* to make the knot at *k*. The base of one of the loops of *p* is pulled out at *l*, the ball passed through the bight and *l* closed by drawing on *p p*. The end cord *h* returning from the circuit is then bound over *k* with half hitches and concealed in the hanai which the ball cord *a* commences with one of the loops of *p*.

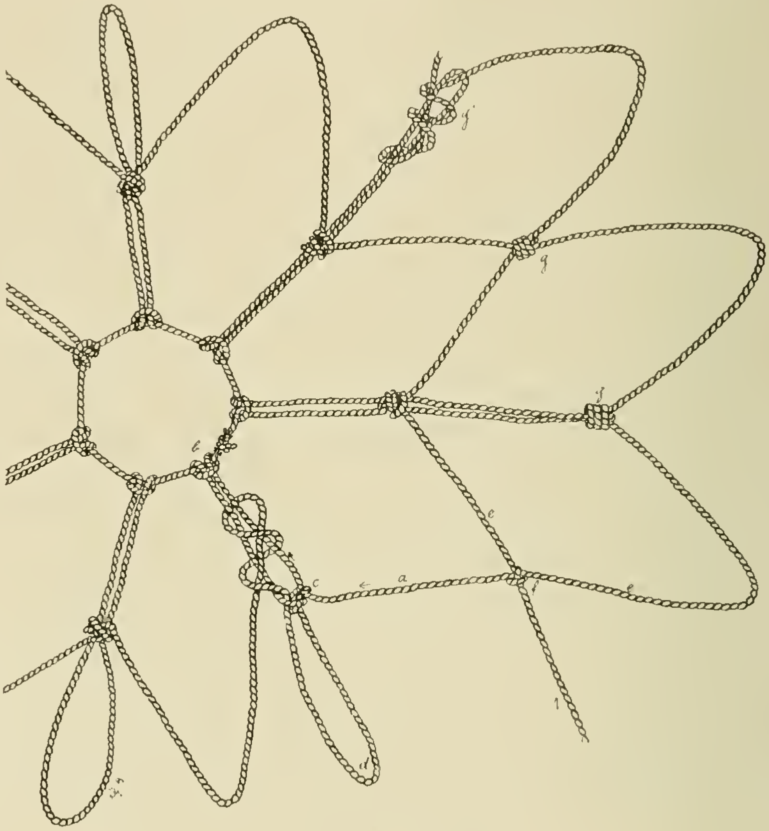


FIG. 112. PIKO B, HANAI B.

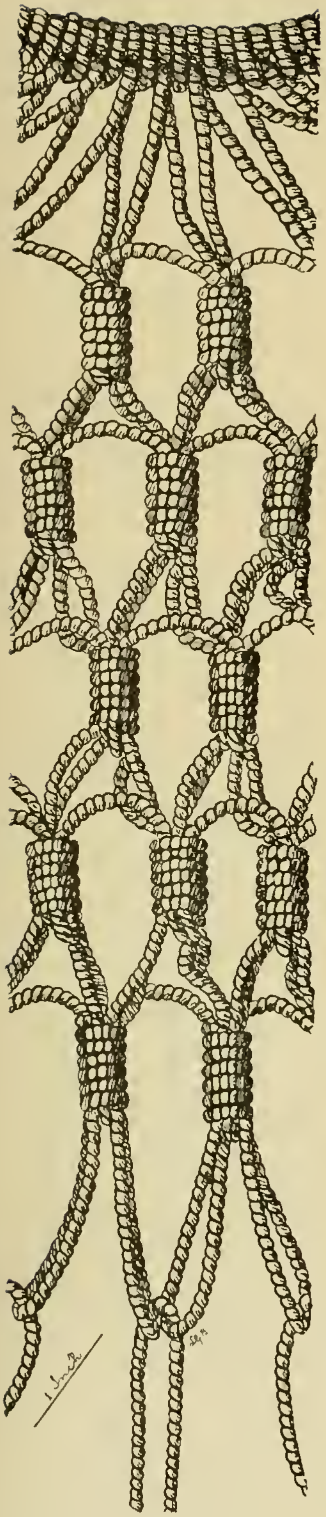


FIG. 113. HANAI D.

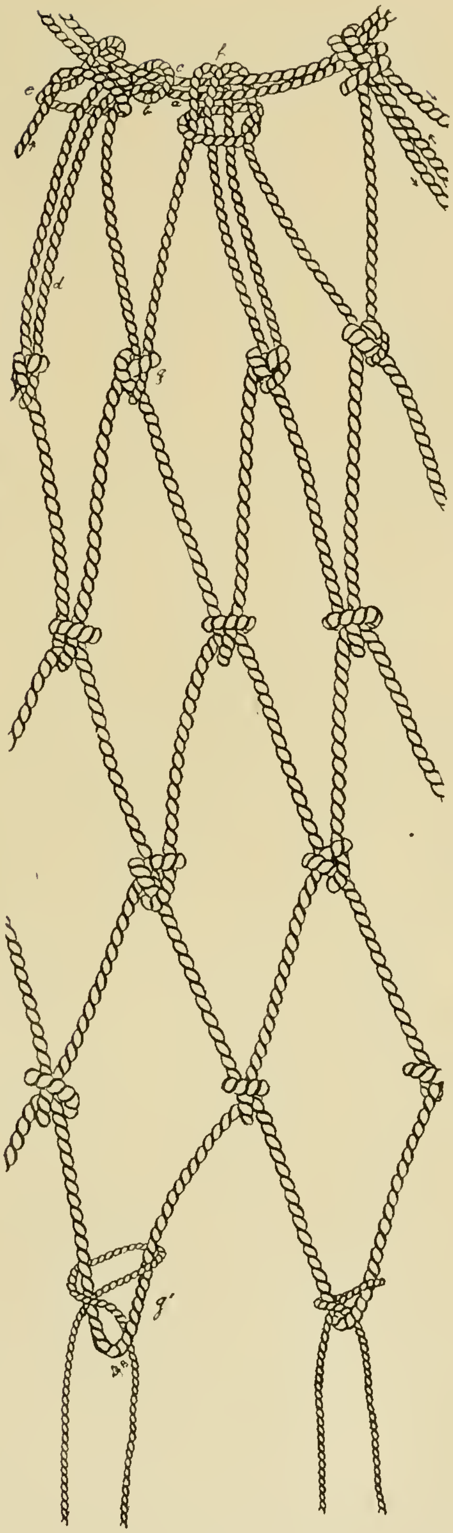


FIG. 114. PIKO C, HANAI A.

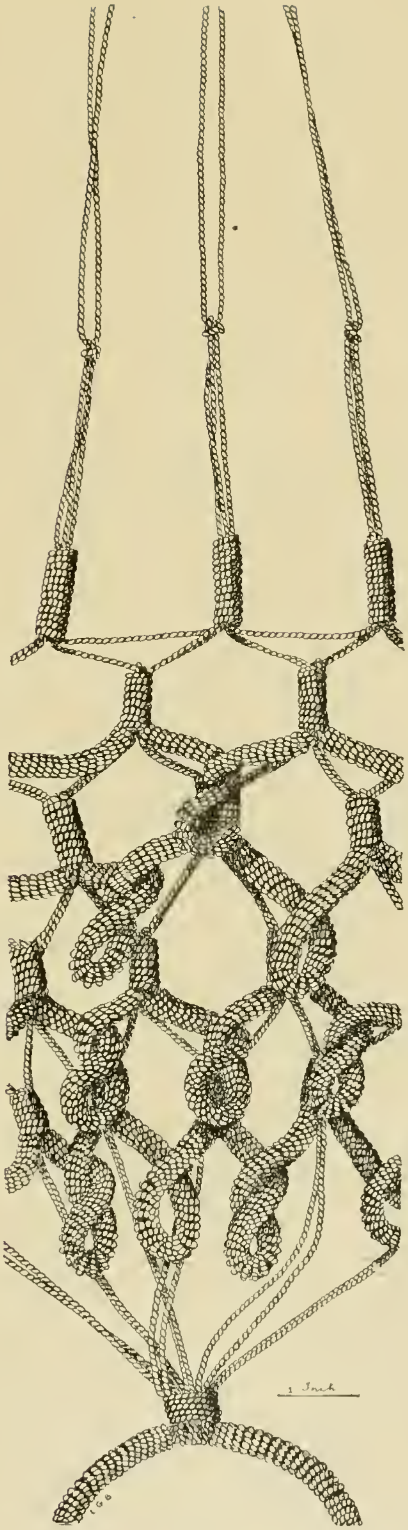


FIG. 115. HANAI F.

Piko M (Fig. 129).—With the end cord *a* the slip knot *a b c* is made. Then a loop *d* of the ball cord is slipped through *c* and the ball passed once around the base of *c* at *e* leaving a loop at *f*. Through *f* another loop *g* is passed, the ball cord returning at *j*, with which *h* is made similarly to *d*. The appearance of the piko completed is given from *j* to *k*, and strongly suggests crochet.

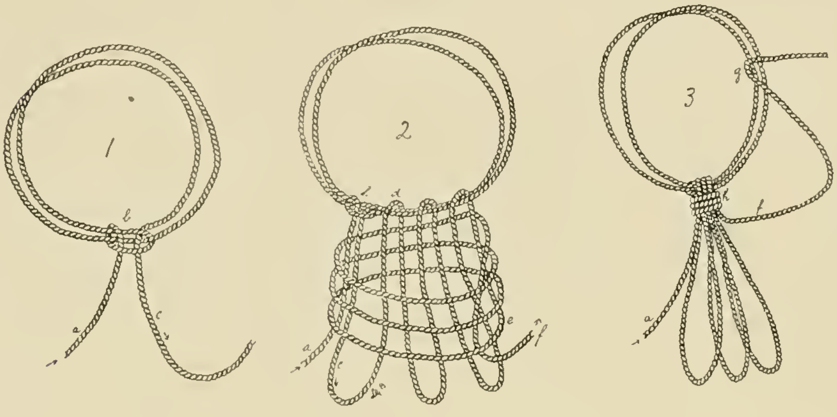
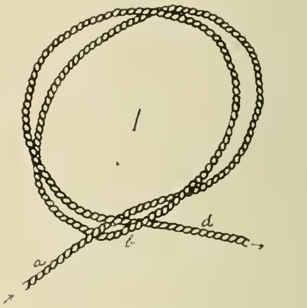


FIG. 116. PIKO D.



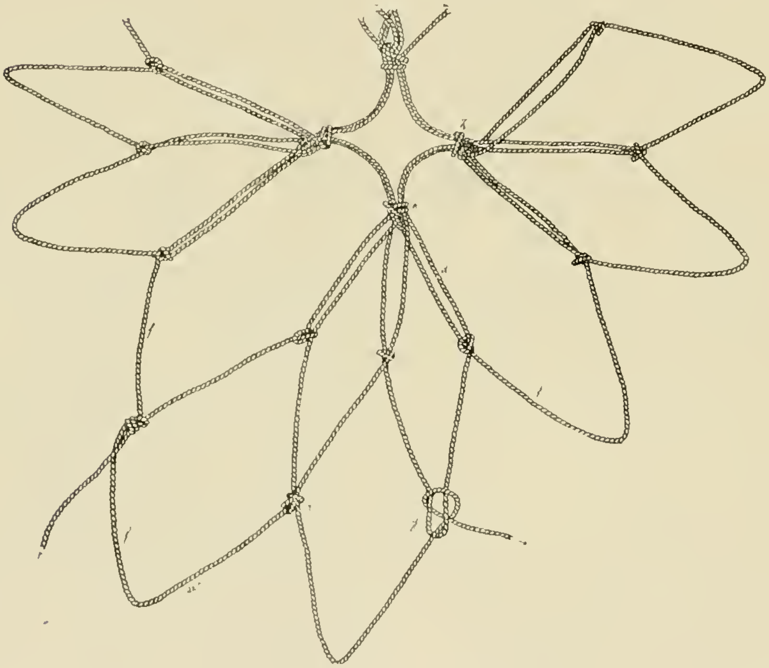


FIG. 118. PIKO E, HANAI A.

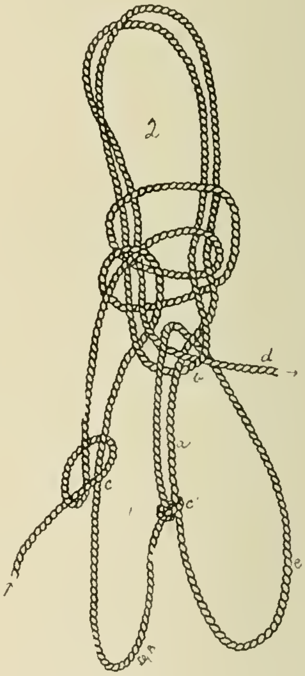


FIG. 117. PIKO E.

Piko N (Figs. 130 and 131).—Now, if in Piko M, the cord *e* were wound around *c* twice or more, it would represent Piko N. To commence this piko, a slip knot is made, *b c d*, and the ball cord *f* wound round the end cord *a* at *e* from two to ten times as wanted; then a loop *g* of the ball cord is pushed through the windings, returning at *j*. This knot can be and probably was made in a simpler way. With the ball cord *j* looped through *g* at *h*, the loop *l* is made leaving a large slack at *m* and *n*; then this slack is tightly wound around *g* and *l* the required number of times, the balance of the slack being taken in by drawing on *l*. Reference should be made to the knot in Hanai D in Fig. 137.

PIKO O (Figs. 132 and 133).—In Diagram 1, after doubling the cord at *g* make the loops *b*, *d* and *f* with the ball cord, leaving enough slack. Then lay the ball cord *c* along the bends of the loops and wind the slack *c* a few times around the whole. Then loop the cord *a g* at *h* and continue winding with *c*. When the slack of *c* is

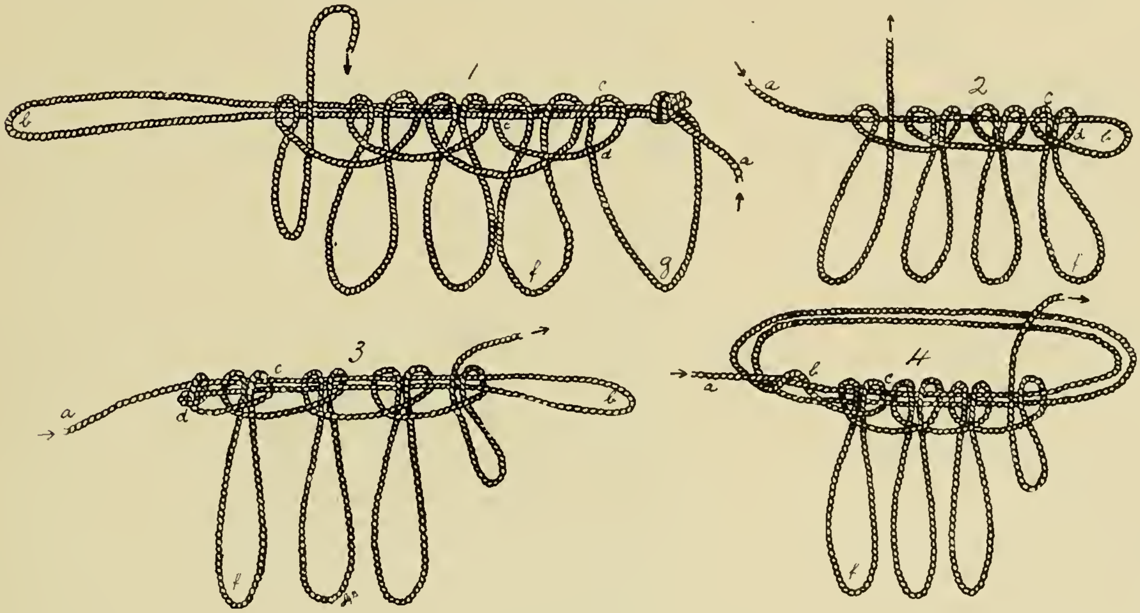


FIG. 119. PIKO F.

taken up by *c*, the knot *x*, Diag. 2, will serve to begin the piko, and the details of the regular knot are shown in the same diagram. *X* being completed, with the ball cord *c* pass the loop *b′* through *d* leaving slack at *h′*, and over *b′* lay *c′* and the loop *d′*, leaving another slack at *c′*. Then *c′* is bound around all the cords on a level with *d*, and as the binding proceeds, the slack *h′* is divided into two loops, *h′ h′*, Diag. 3, and held in place by *c′*. Sometimes the ball cord *c′* is not laid along *d′*, but is carried forward outside *y*. In such cases this piko differs from Piko N only in the additional loops *h h′* projecting from the side. Fig. 132 was drawn with the details in an upright position. Fig. 133 shows this piko, which in the specimen photographed was small.

Hanai.—The hanai begins where the last loop of the piko was made.

HANAI A (Figs. 114 and 118).—This is the simple fisherman's knot, known by natives as *ka*, *umii*, etc., as shown by *g g′* in the figures.

HANAI B (Fig. 112) is the fisherman's knot with one or more extra windings around the engaged loop, as at *g* and *g'*.

In some of the koko puupuu the knots of both Hanai A and B are used as in Fig. 134. Fig. 135 is a specimen of koko puupuu with Hanai B.

HANAI C (Figs. 110, 111 and 136).—This is the square or reef knot, *makili*, *g g'*, Fig. 110. Sometimes in beginning a large hanai, additional loops *h*, Fig. 111, were run on to the loops of the piko for the purpose of enlarging the periphery of the hanai.

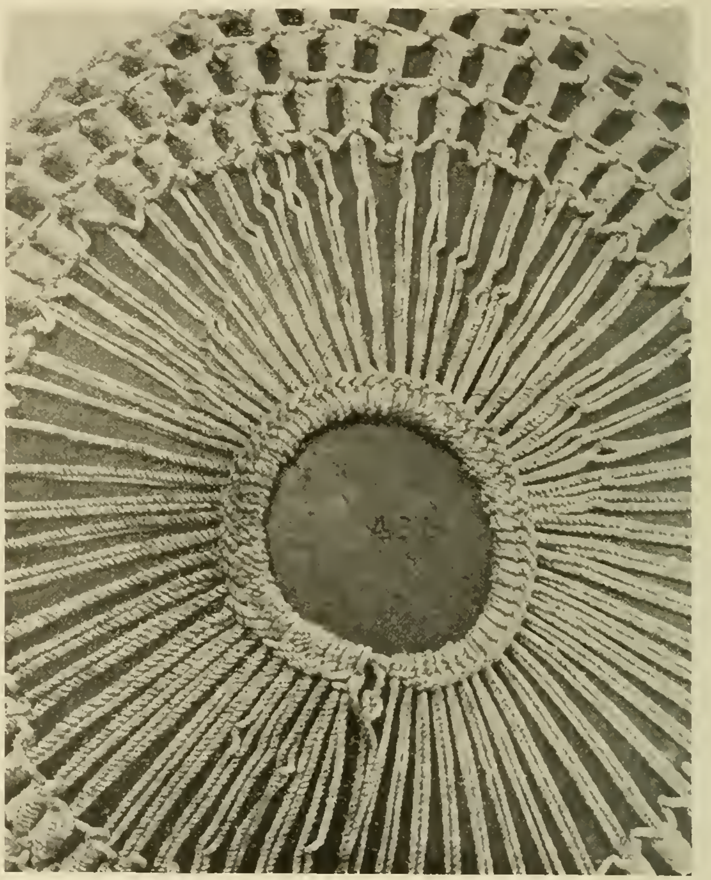


FIG. 120. PIKO F. OBVERSE.

Fig. 136 shows the specimen from which Piko D, Fig. 116, was illustrated. This was a particularly well made and finished netting used as an *eke*. On completion of the piko the shuttle cord *k* was looped at *n* (without tying to the free end *a*) and knotted to the piko loop *p* and so carried round the circuit to *l*. The cord *l* was then looped and the rows of the hanai completed, the work travelling boustrophedon. To join the ends of the rows, the shuttle cord *m* is brought back from the outer edge of the hanai by knotting from side to side until tied with *a* to *k* at *r*.

The three foregoing styles represent the netted hanai, which have the ends of the rows joined in the manner just described, or else by the free end *a* netted from side to side towards the outer edge.

HANAI D (Figs. 137, 113 and 133).—The principle of this, the basal knot of all the knitted koko, has already been partially illustrated in Piko M, N and O, but since it is so generally used, fuller details of its technique in the hanai are given in Fig. 137. The loops *x x* are those of the piko, and *f* is the completed knot of Hanai D, known to the natives as *puu*. In Diagram 1, the ball cord *a* is looped *b* through the next piko loop, and, Diagrams 2 and 3, the slack *c* being left, the loop *d* is bent and placed under *b*. Then *c* is wound round *b*, *d* and the bight of *x* and the slack taken up by *d* and *e*. In knitting the succeeding row of the hanai, the nearest loops of adjacent puu of the first row are placed together and bound by the outer knots. Sometimes when the mesh of the hanai is intended to be large, two loops of the piko are combined in one puu. And occasionally, but only with the closely knitted koko of coir, the hanai commences with but few puu near the piko, Fig. 133, and the number is doubled by using each loop of the puu of the inner row as a base for that in the outer. In the figure the number of puu in the second, third and sixth rows have been successively doubled.

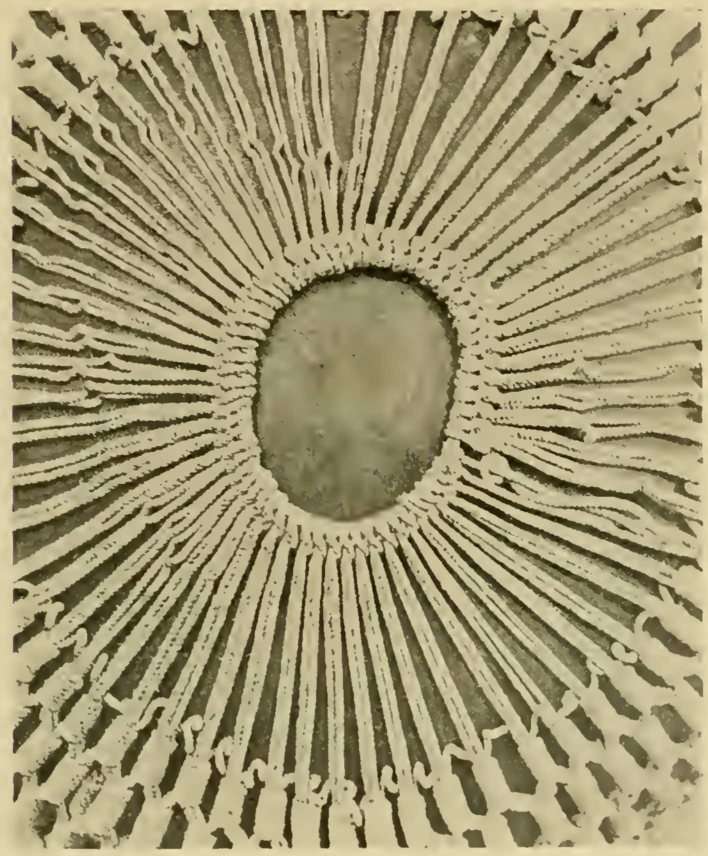


FIG. 121. PIKO F. REVERSE.

The work of the knitted koko was directed either continually to the right, or to the left, or had the alternating rows in each direction; there seems to have been no set rule, but one circuit was always completed before the next began, in which respect it differed from that in the netting. The knitted knot can at once be detected by the cord hanging from and connecting the bases of each puu (see *a* in Figs. 108 and 137). When one row was finished, the ball cord *b*, *b′*, Fig. 108, was carried up with the loop of the last knot to begin the row above.

HANAI E (Figs. 138, 104 *a*, and 105 *a*).—This is the same as Hanai D, except that the outer loops are interlaced before the ends are bound together with the puu.

HANAI F (Figs. 139 and 115).—Before completing the puu, the ball cord *e*, Fig. 139, is looped *g* through the slack *c*, which is taken in as usual. Then round the bends of *g* the ball cord *h* is very tightly wound, finishing at *k*, Diagram 2. Then the bight of *g* is placed on that of *x* and the loop *l* on the ball cord run through *x* and *g*, after which the puu is repeated. A koko of this style, unique in the collection, is illustrated in Fig. 115 in its suspended position.

HANAI G (Figs. 140, 141, 131 and 105 *c*).—This hanai, in addition to the puu of Hanai D, has from one to three knobs constructed like the puu, attached to the base. Fig. 105 c, shows this hanai in inverted position with one knob attached, and Fig. 131 the same style with the three knobs, in which case the name of the koko was koko puupuu *huihui*. Following the completion of the puu, Fig. 140, the ball cord *e* is looped *g* around the connecting cord *a* and the puu repeated (*o*, Diag. 3) the loops *g* and *j* being drawn flush with the wound cord. This is followed by a similar puu, *p* and *r*, on the bends of *x*. Diagram 4 shows the under side of the huihui. In Fig. 141 the puu *o*, *p* and *r* are all made around *x* and *a*. It has been observed that if the mesh of the koko is small, the rows of knots alternate with the styles of Hanai D and G.

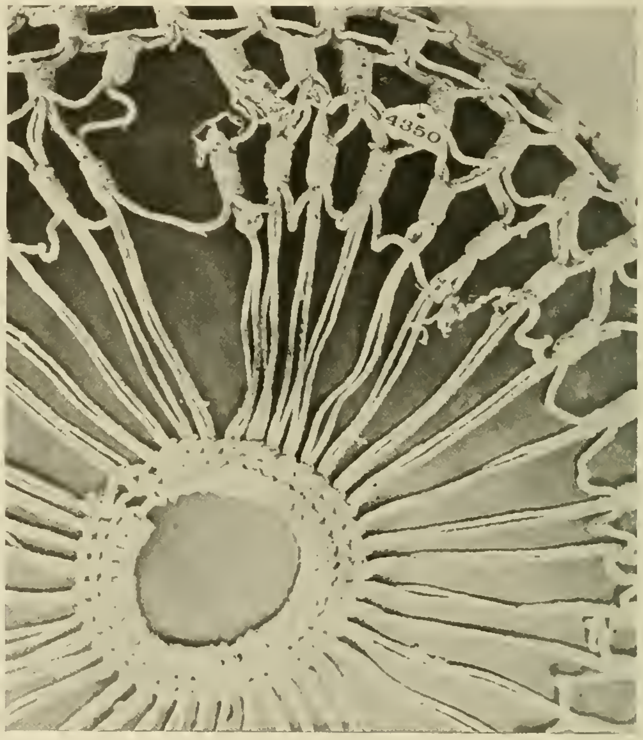


FIG. 122. PIKO F.

HANAI H (Figs. 142 to 144).—This hanai has from one to three puu looped around the puu of Hanai D. The method is similar to that in Figs. 140 and 141, but the loop *j* is allowed to project slightly from the puu *o*. In Fig. 142, the puu *p* is attached to the base of *o* and the loop *n* allowed to protrude. Then *n* is passed through *j*, slipped over *b* and *d* and drawn tightly around the base of *b* and *d* by the ball cord *m*. Fig. 143 shows a koko with the piko half of the hanai, coir and style D, and the kakai half, waoke and variations of Hanai H. In Fig. 144 is given an illustration of the outer rows of a koko in suspended position, the body of which is of Hanai H as shown in the lower knots, and the upper edge of Hanai J.

HANAI J (Figs. 144 and 145).—It is probable that koko exist which are made entirely like the upper row of that in Fig. 144, though there are none in the Museum. In Fig. 145, Diag. 1, after the puu *f* is complete, the ball cord is looped, *g*, and passed around *x* and *a*, and a series of half hitches are slipped over *g*. As the half hitches approach the loops *b* and *d*, the latter are each included in a half hitch in turn. Diagram 3 shows the reverse side. When attaching the bight of *g*, Diag. 2, the ball cord is looped at *j* leaving a slack at *l*, the loops *g* and *j* bound together by one turn and the binding continued around the whole as with the puu.

HANAI K (Figs. 146 and 105 *d*).—This follows J as far as the loop *h*, which does not encircle *x* and *a* (Diag. 1, Fig. 146). Then two half hitches are slipped over *g* and drawn tight, a loop left and two more half hitches added. Diagrams 1 and 2 were drawn from the reverse side, and Diagram 3 from the obverse. As *g* passes between *b* and *d*, one of the loops on *g* is run around *d*. To complete the knot, *h* is laid on *x*, and *g* and another loop *j* added, when the whole is bound together in the usual way with the slack *l*. In this hanai (see Fig. 105 *d*, with the koko inverted), the knots in the succeeding row are placed directly in front of those of the previous one, while the loops *b* and *d* of one puu are not separated as in all the other hanai.

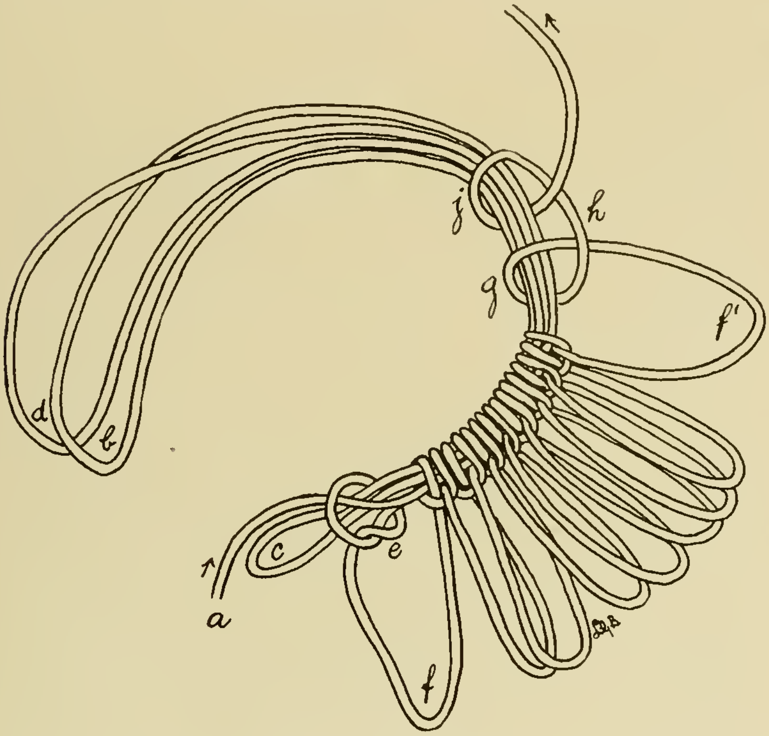


FIG. 123. PIKO G.

HANAI L (Fig. 147).—This hanai shown in the figure in suspended position was constructed so as to leave four circular spaces reaching from top to bottom. The pillars of the body were made with the puu of Hanai D very closely knitted and the ends of the rows finished with the puu of Hanai G. Each pillar was completed before the next was begun. The rows are fourteen puu wide at the piko, decreasing to three at the middle and increasing to thirteen at the outer edge. As the work proceeded, the ends of the rows were embroidered with two additional puu as in Hanai G on one side and one puu on the other, and a row of such puu was attached to the connecting cords of the last row on the pillar. The cord is then at the outer edge of the hanai and is brought to the piko by intertwining with the puu on the side of the pillar last mentioned, and an additional puu knitted to the end of each row. The last pillar being made, a row of simple puu is run around connecting the outer edges of the hanai.

HANAI M (Fig. 148).—This is really an elaborate form of piko finished with a single undulating row of puu. The koko is shown in Fig. 148 in an inverted position, and is unique in the collection. When suspended, it has the appearance of an arcade with the flooring angularly channelled. The first step in making this koko was the construction of an arch in the same manner as Piko F, the loops on the pillars being very short and on the arch of various lengths. Inside the arc, to stiffen it, was placed a piece of coir. The six arches complete (probably in separate pieces), the pillars were joined by running fine double cords alternately through the small loops of the opposing sides. Then a row of twelve long puu was attached, one puu to the base of each of the original pillars, and joined together in pairs by a row of six short puu. The basal cords, the arches and pillars having been included in the long and short puu, were incorporated with other loose ends in a piko roughly made after the style of Piko N. To the outer edge was added a row of Hanai D, which made it ready for the kakai.

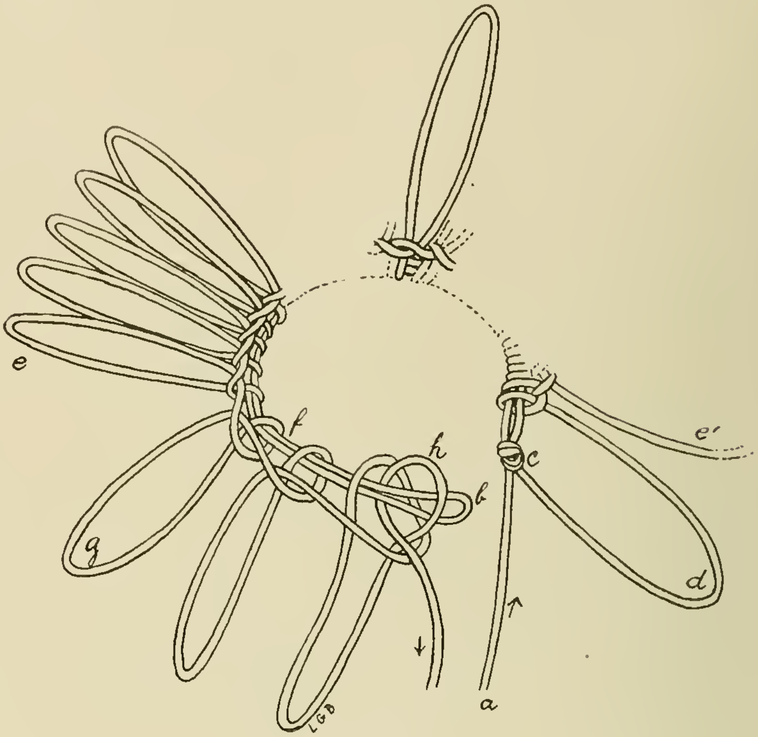


FIG. 124. PIKO H.

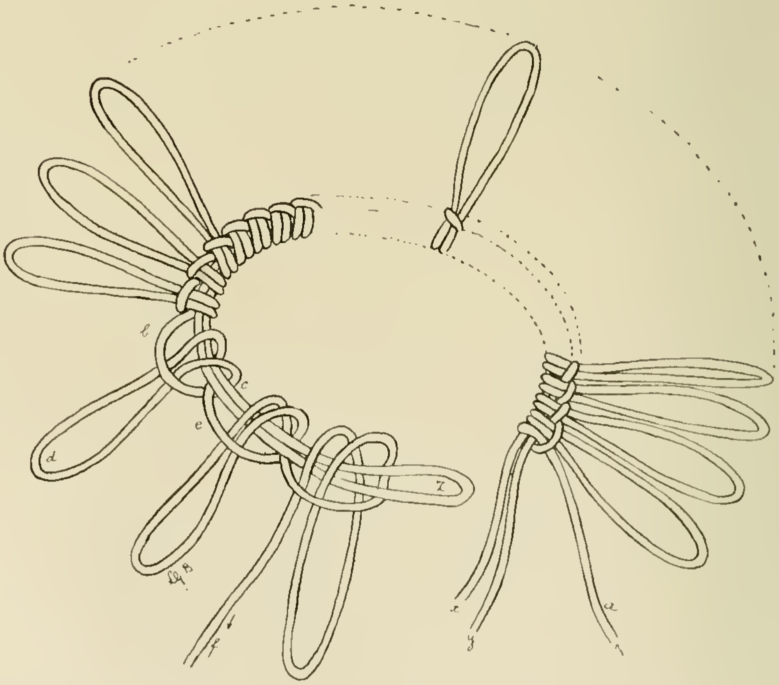


FIG. 125. PIKO J.

Kakai.—The strings of the kakai were gathered together at the pu by two methods. In all the better class koko and many of those used by the common people, the pu was evenly and smoothly wound with the end of the cord, which winding was termed *uo*, Fig. 153. With the pu uo, the kakai was as a rule divided into two series of strings, and was rarely gathered together as one pu; this latter condition most frequently occurred with the commoners' koko, when the pu was composed of half hitches, termed *lino*. It was somewhat awkward to take out the umeke from a koko with a single pu, the only opening being between the strings of the kakai, but all the koko of this kind were of coir and most of them around the large bowl-shaped gourds for transporting water, so it is quite probable that it was not intended to remove them often. In length the kakai was about equal to the hanai and piko combined, inclining if anything to be slightly shorter.

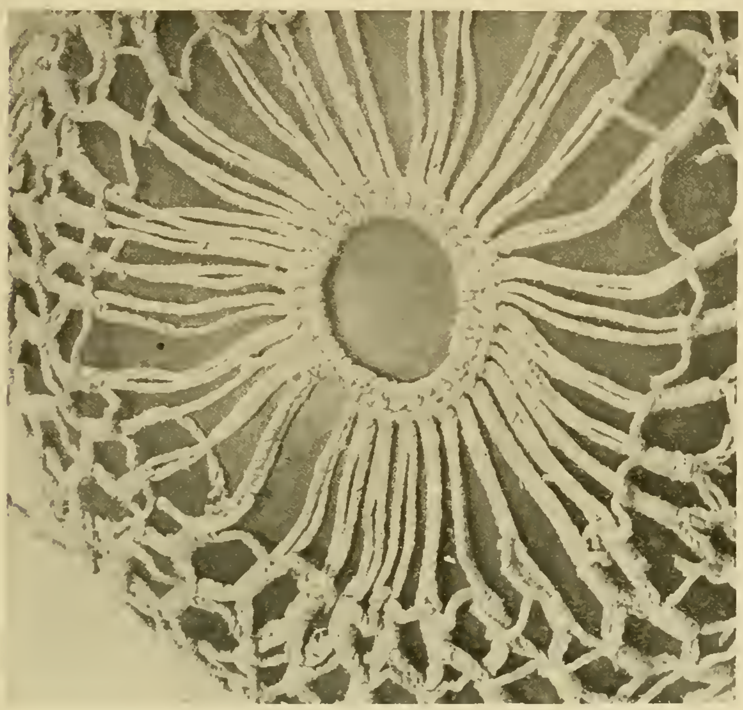


FIG. 126. PIKO J.

There is a remarkable form of netted bag in the Museum, No. 4454, Fig. 149, the material and workmanship of which is not recognized as Hawaiian by any native who has seen it. It was in the late Hawaiian Government Museum, and came to the Bishop Museum as a Hawaiian koko with the rest of the collection, but the curator of the former institution can give no information, and consequently none of its history is available. However, an old native claims to have seen some such nets in the time of Kamehameha V (1863-1872), when they were considered foreign. The material has the appearance of jute, dyed an indistinct blue-green on the surface, but there are sure signs that the cord was not made by machinery. It differs from the Hawaiian koko in having been made from a number of cords, and these cords diverge from a piko filled in with matted string suggestive of the plaiting in straw hats (*a*, Fig. 149). Another point of difference is the four separated handles in which the cords of the hanai are incorporated, each handle (*b*) being a square braid of twelve strands. The technique, Fig. 150, is the same as observed in the simpler portions of macramé work, and also the netting or basket of fern stems around certain Japanese flower vases. Another bag, No. 4455, is made in the shape of a koko with the hanai of black wool netted as in Fig. 150, and a kakai of heavy cord similar to that in No. 4454.

The koko were divided into two classes by the Hawaiians: the koko puupuu, the property of the chiefly class, *alii*, and the koko pualu, used by the *makaainana* or plebeians. Mechanically there was no difference between the koko pualu and some of the koko puupuu, but those of the chiefs were always recognized as being better made, more elaborate and of superior cord.

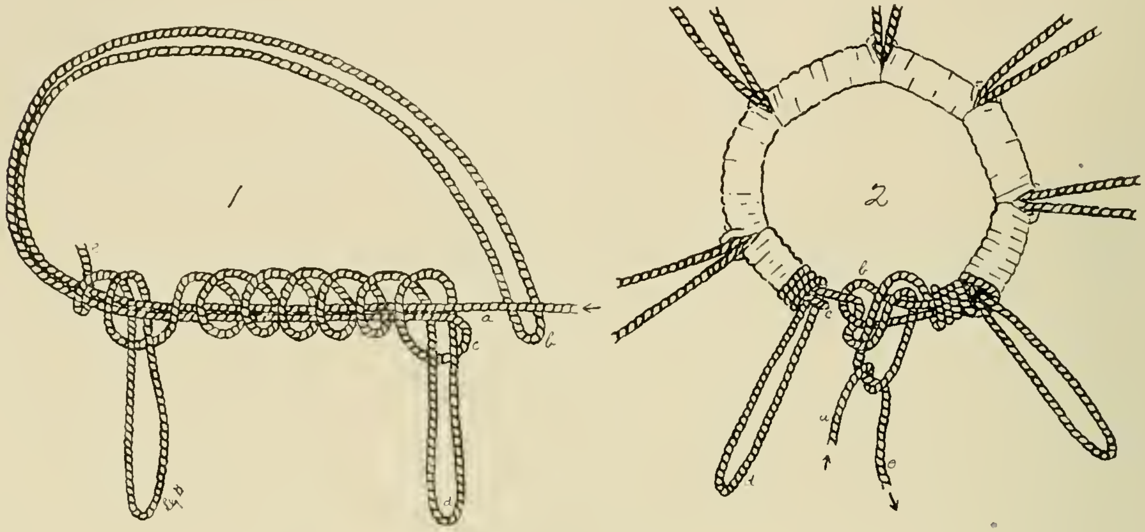


FIG. 127. PIKO K.

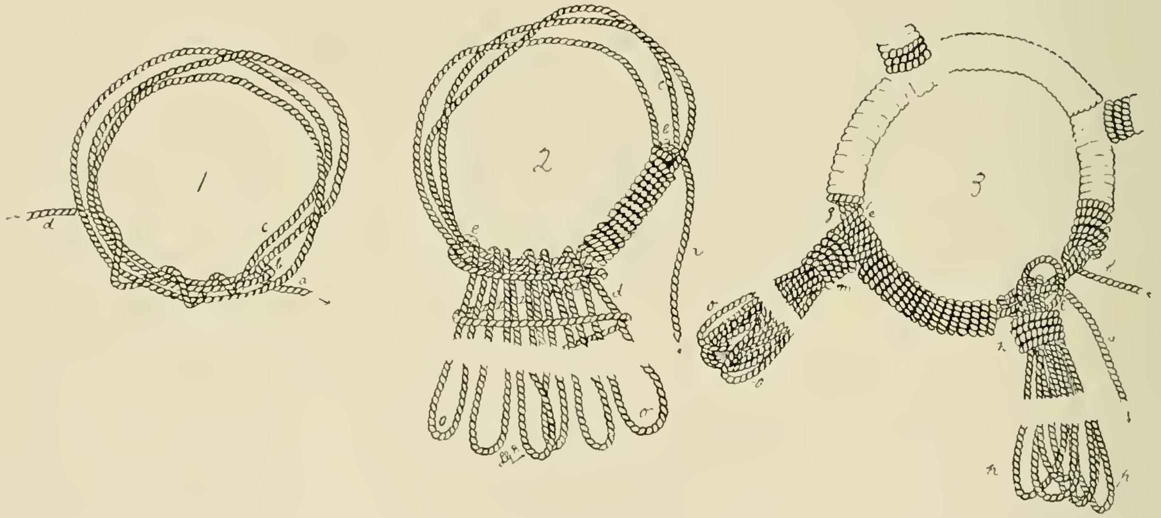


FIG. 128. PIKO L.

Koko Pualu.—The koko pualu was a plain netted bag, made of coir, hau or ahuawa, Figs. 104 *b*, 114. The term pualu was little used to designate this class. The material most generally employed in making the koko pualu was coir, and a coir koko of the class pualu would be referred to merely as *koko*. To one made of ahuawa the name koko ahuawa was applied, while the chiefs' koko were never known otherwise than koko puupuu. The knots used in the structure of the koko pualu were the ka, and more rarely the makili. The mesh was always large and plain.

A variation of this form with a smaller mesh was employed to carry such articles as sweet potatoes, taro, etc., without the aid of an umeke. It was made with a piko and hanai as in the koko pualu, but instead of the kakai as shown in Fig. 108, a cord was run through the outer selvage of the bag, thus serving to close the opening and act as a handle. This implement was known as an eke or *laulau*.

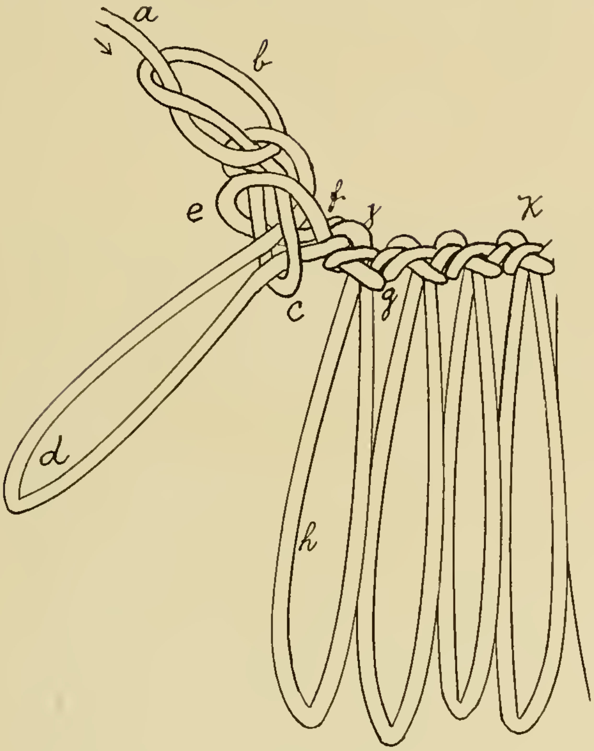


FIG. 129. PIKO M.

Koko Puupuu.—The koko puupuu was reserved for the sole use or service of the alii, who were exceedingly jealous of their dignity, promptly punishing by death any presumption on the part of a plebeian in making personal use of such a koko. One reason for which a makaainana might carry the koko puupuu for his own needs, was protection against robbery by the kahu of some alii for his master. A commoner carrying food in a koko pualu was always liable to have it appropriated by any one of higher rank than himself, since the koko pualu indicated that it was only the belonging of a makaainana; but the subterfuge of utilizing a koko puupuu, implying that the carrier was in the service of a chief, would protect the property unless the man were found out, when the consequences to himself would be

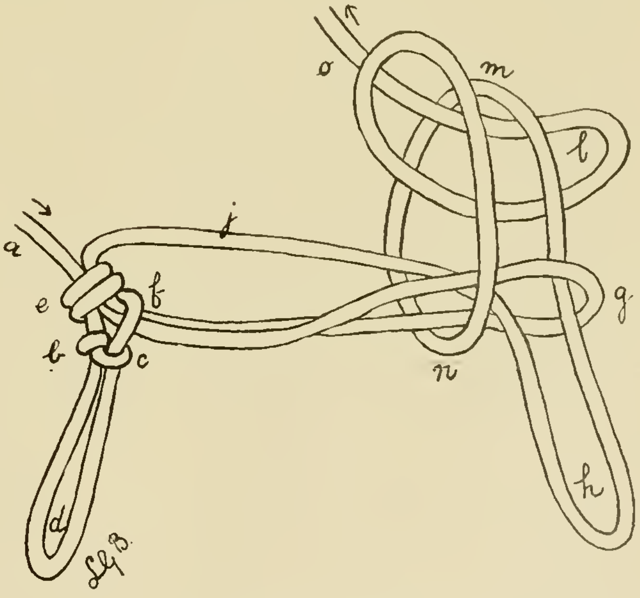


FIG. 130. PIKO N.

very disastrous. This koko took its name from *aipuupuu*,[38]—the steward of a person of high rank, deputed to carry and care for the alii's food. The modern native gives the meaning of puupuu[39] in this connection as a complicated or thick knot, of which this koko is generally formed, but since some of the koko puupuu are of simple netting, Fig. 134, though of very fine mesh, it would seem that the derivation of the name came through the word aipuupuu, the explanation of which was contributed by a very old native fisherman.

The material in the koko puupuu is mainly waoke, but coir, oloná, and in later days horsehair, were also used. Frequently the piko and lower part of hanai are of coir, and the upper part and kakai of waoke, rarely oloná, Fig. 104 *c* and *d*, and 105 *b*, known as *pauku*. Occasionally two or more materials, generally coir and waoke alternate in rows, when the koko puupuu is termed *ouionio* or *paukuku*. It is quite possible that horsehair succeeded human hair, which was used very extensively in the neat braid of the *niho palaoa* and for decorating fan handles.

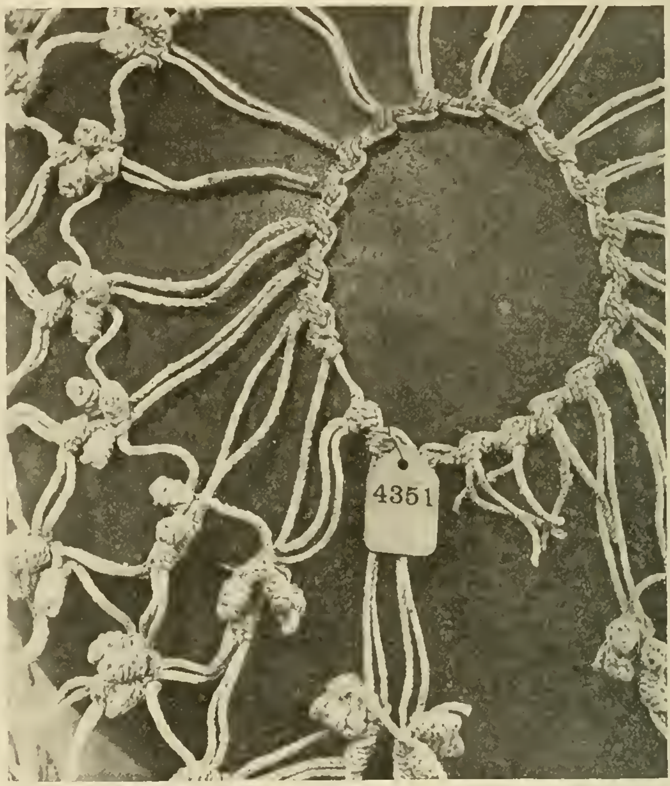


FIG. 131. PIKO N, HANAI G.

The knots in the hanai were either knitted or netted, taking for the application of the word knitted, a slip knot, or one that when formed may be undone by drawing on the last end of the cord. The knitted knot is shown in detail in Fig. 137 and following.

It might be here mentioned that enquiry among the older generation of living natives elicited almost no information concerning the manufacture and use of koko, particularly the koko puupuu, as these articles have been out of use for many years. One old man explained that he had seen his grandfather make them, but that he himself had had no use for them so did not take the trouble to learn. However, he could make good fish nets! There are a few natives in Honolulu who make koko for sale to tourists, but they unfortunately did not acquire the art by inheritance, merely having picked it up by unravelling some old specimen.

---

[38] Aipuupuu = callous-necked. These men (class) were always recognized by a large callus on the shoulder, caused by the auamo, and were very proud of the mark denoting their office.

[39] Puu, puupuu, pu and pupu, in Hawaiian are very closely allied. Puupuu and puu mean, in short, "Any round protuberance belonging to a larger substance." (See Andrews' Hawaiian Dictionary.)

It was particularly desired to learn the exact process of the native knitting and the names of such styles of hanai as E, F, H–N, and failing native sources, a thorough search among old voyages was carried out, with poor results. Only two works mention the existence of the koko. Freycinet wrote of the nettings for gourd bowls:[40] "Après le repas, on pose un de ces plats sur l'ouverture de la calebasse qui contient la poé, et le tout est surmonté d'un couvercle, qui n'est aussi qu'un morceau de calebasse; le tout est enveloppé et assujetti dans un filet à larges mailles, qui sert à le suspendre." Wilkes gave several illustrations of the methods of carrying, and remarked:[41] ". . . . they [calabashes] are surrounded by a net made of fine twine or sennit of the cocoanut."

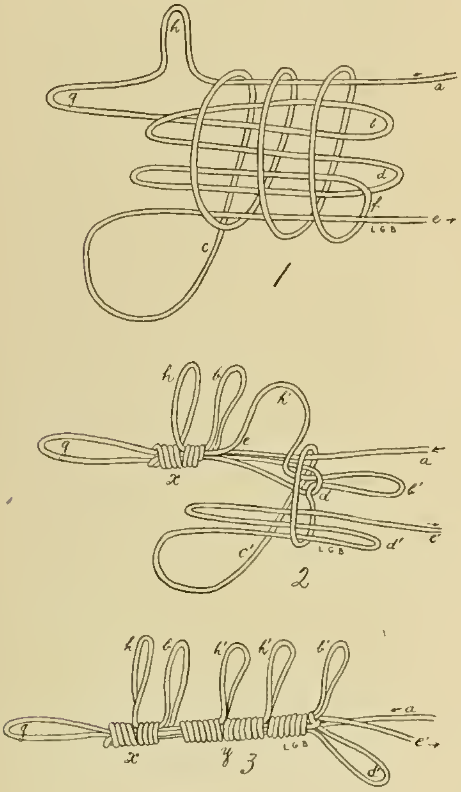


FIG. 132. PIKO O.

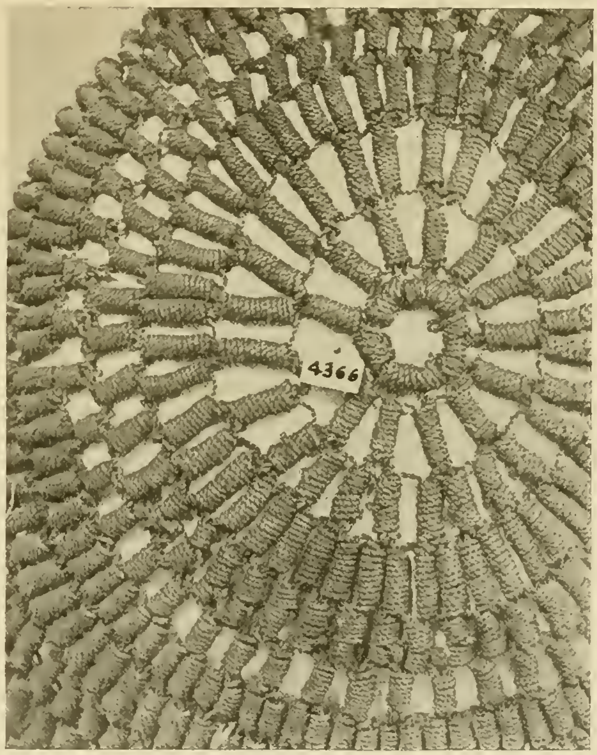


FIG. 133. PIKO O, HANAI D.

It might appear that the knitted knot, the puu, was a conception entirely Hawaiian, for none of the other members of the Polynesian race seem to have possessed such a knowledge. However, some doubt has occurred to the writer as to whether it was even native. The koko noticed in the narratives just mentioned, as a reference to the volumes will show, were koko pualu and of course netted, while some of the koko puupuu, Figs. 115, 147 and 148, were surely too remarkable to have escaped observation. All the older natives conversed with and enquired of claimed that the puu was very ancient—long antedated the advent of Captain Cook. Still, too great reliability cannot be placed on these claims when the history of the Eskimo netting needle mentioned among the tools is considered. A comparison of the puu with the knot commonly known as the hangman's knot will show that the former is but a slight modification of the latter. Foreign sailors have closely associated with the natives since 1778, and the sailor with his knowledge of knots on the one hand and the native on the other eager to learn the foreigner's ways would make it a simple matter to introduce a new method into their work. A koko puupuu of waoke in the Museum, No. 9050, and another of oloná, found in the possession of a gentleman in Honolulu, were begun in the native way with Piko F, but had the hanai made of simple knitting, Fig. 151, and finished with a row of the puu. It is known that the natives were taught plain knitting by the missionaries, who came here in 1820, and proved

---

[40] Freycinet. Voyage autour du monde. Historique, Tome II, pp. 582; Atlas, pl. 86.

[41] U. S. Expl. Exped. Narrative, Vol. IV, p. 96, plate opposite p. 55, and other illustrations.

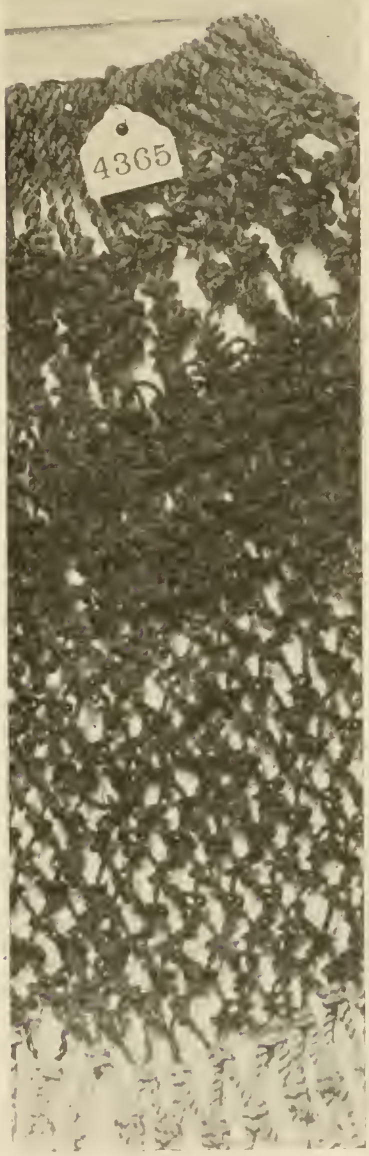


FIG. 134. HANAI A+B.

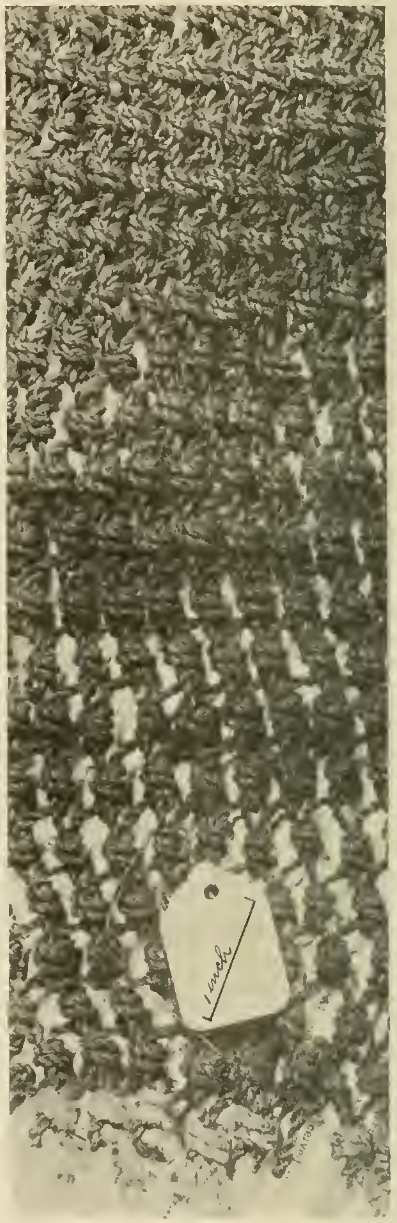


FIG. 135. HANAI B.

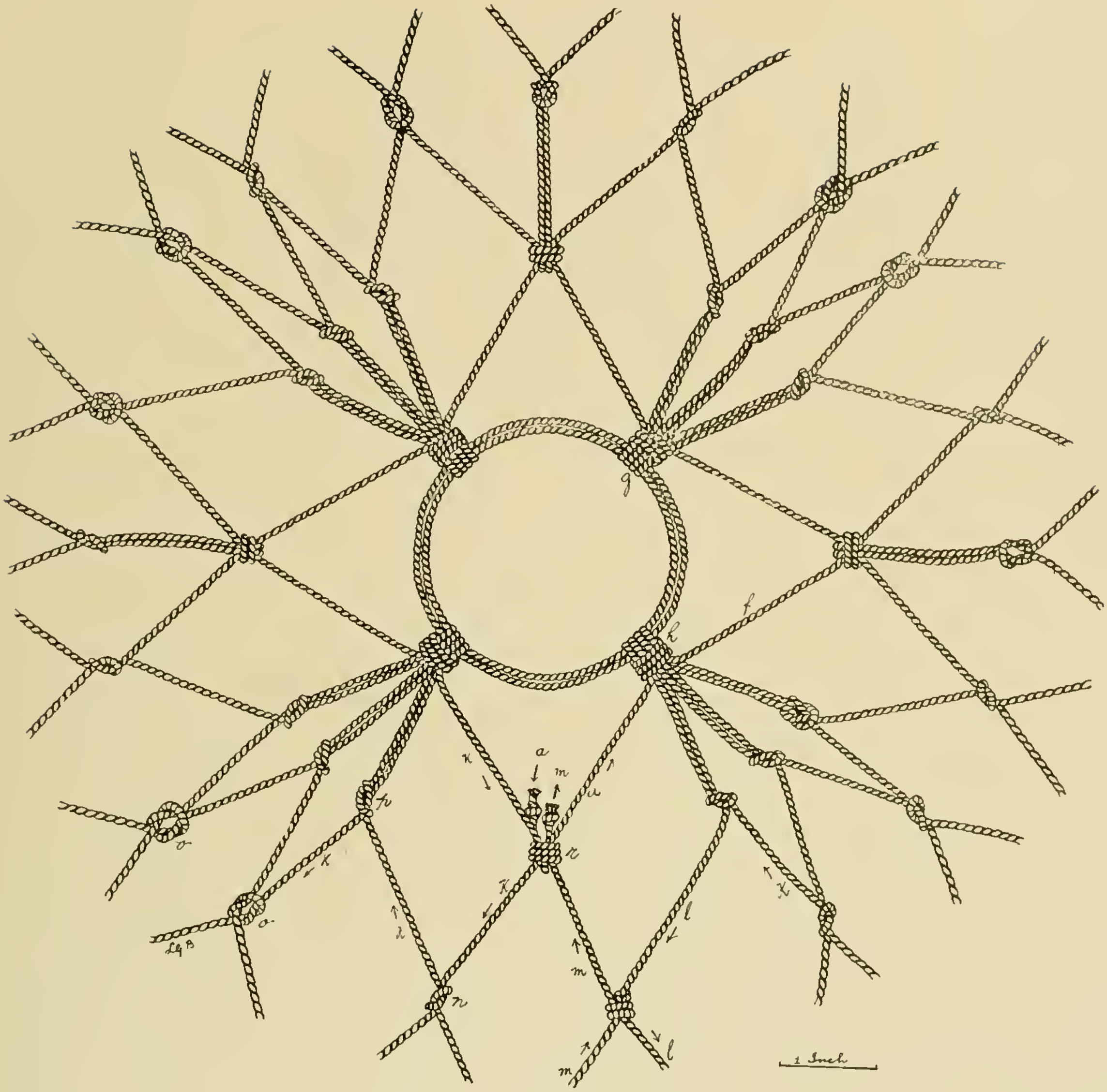

a
m
g
h
f
n
u
r
p
k
o
l
m
n
1 Inch

FIG. 136. HANAI C, PIKO D.

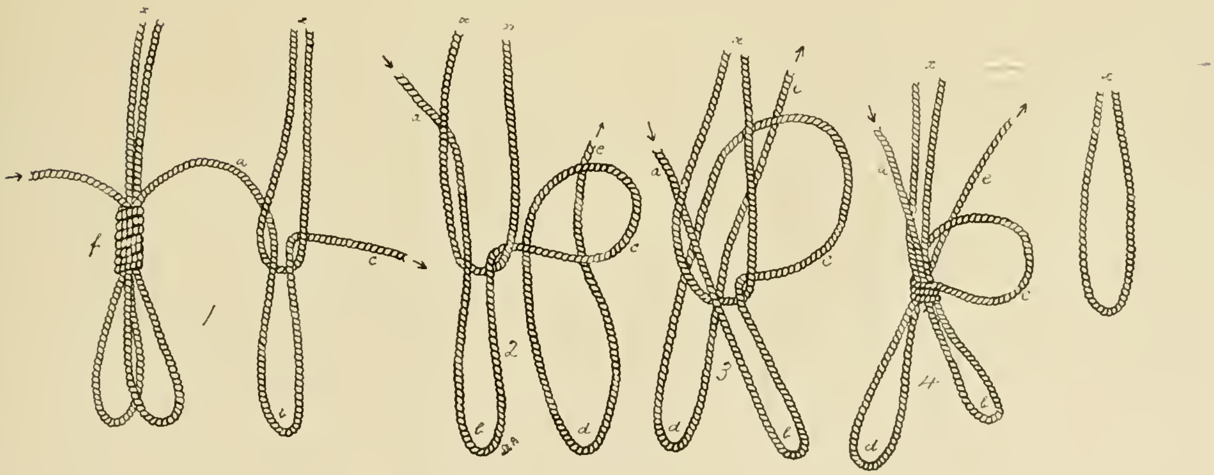

x
f
a
c
1
2
3
4
d
e

FIG. 137. HANAI D.

apt pupils. It may be that the natives owe the knowledge of the puu to Juan Gaetano's Spaniards of about 1550, as with the shapes of their remarkable feather helmets.

However, no matter what the origin, even if the knot were of foreign introduction, the natives had seen its adaptability to their work, and by their adoption of it into the manufacture of their articles, they have surely given it a domicile sufficiently Hawaiian.

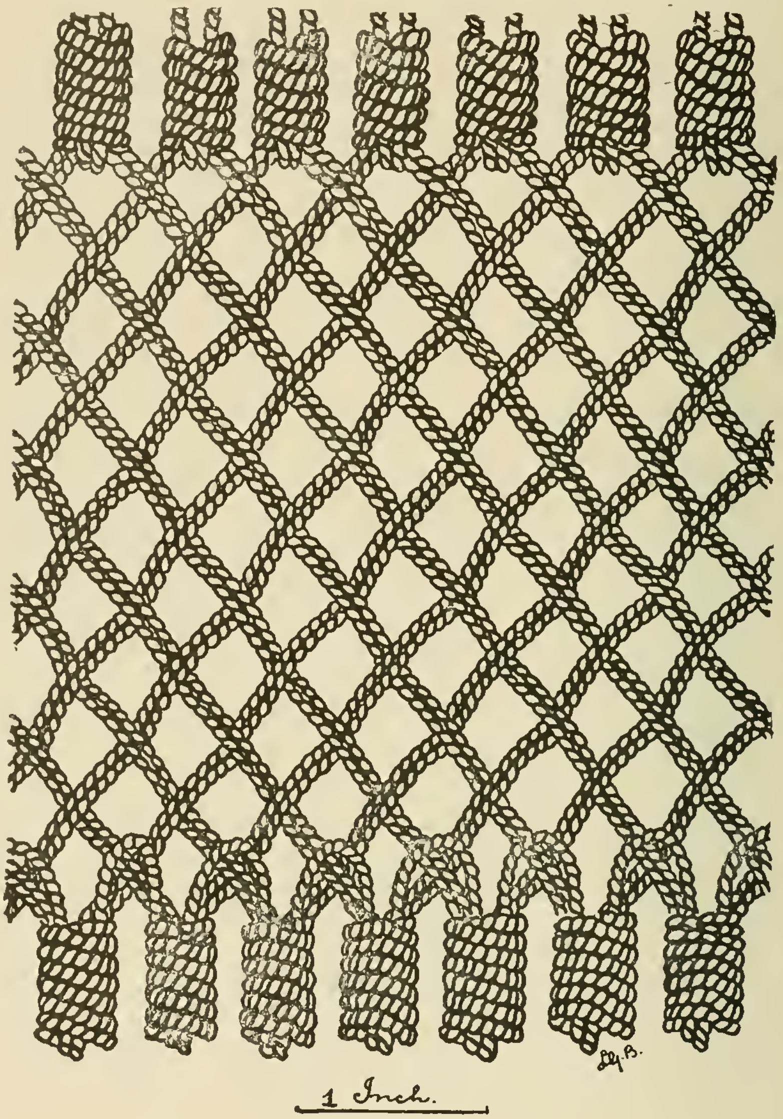


FIG. 138. HANAI E.

There are many attractive patterns in the koko puupuu, to which no native in these days is able to attach any significance or name. One old native, after being questioned in vain, remarked disgustedly: "The haole (foreigners) want all the time to put a number or a name on everything, but these to the natives were just koko." It was thought by the writer that the different grades of alii (which were multitudinous) might be entitled to distinct styles of koko, and without doubt, the greater the chief, the better was the koko. Certain chiefs were entitled to a particular form of tabu (or kapu) and in their presence, or when their food was carried by, the common people were required to fall on their faces, sit or kneel, according to the order of the tabu. It seemed quite feasible that certain of the koko might designate the rank of the owner by the pattern and so make it known to the people, but Dr. Alexander, a recognized authority of matters Hawaiian, stated that for the purpose of proclaiming the degree of chiefship, a crier was sent before the

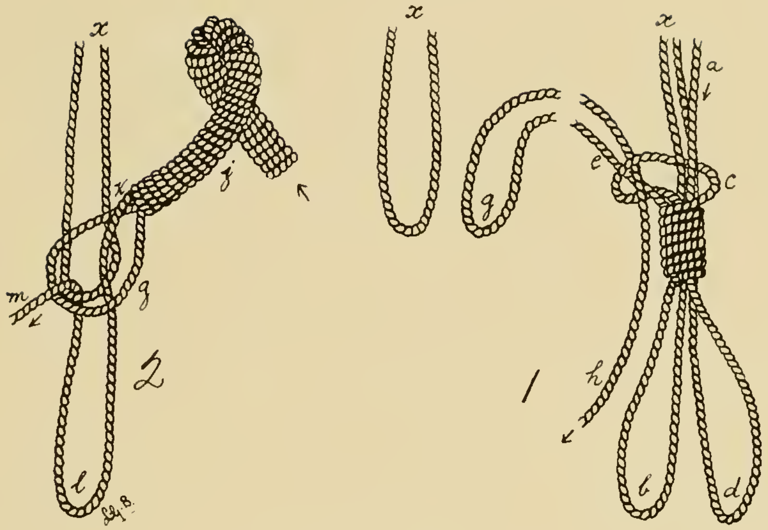

x
j
k
g
m
2
l
x
x
a
e
c
g
h
1
b
d

FIG. 139. HANAI F.

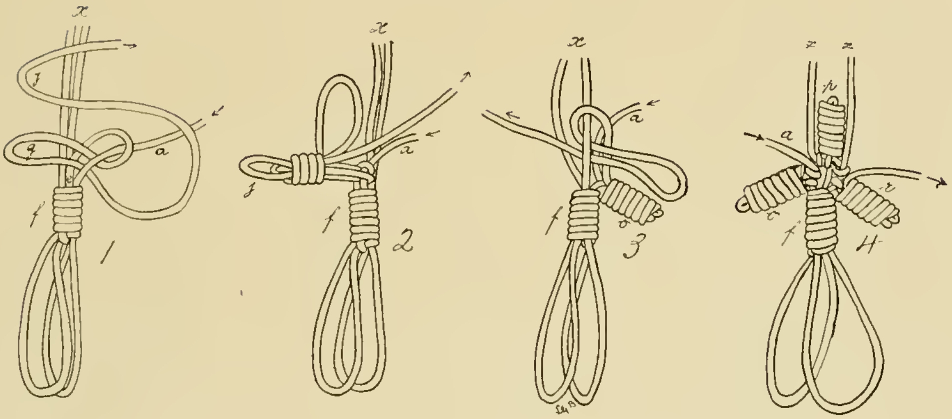

x
j
g
a
f
1
x
a
j
f
2
x
a
o
f
3
x x
p
a
r
f
r
4

FIG. 140. HANAI G.

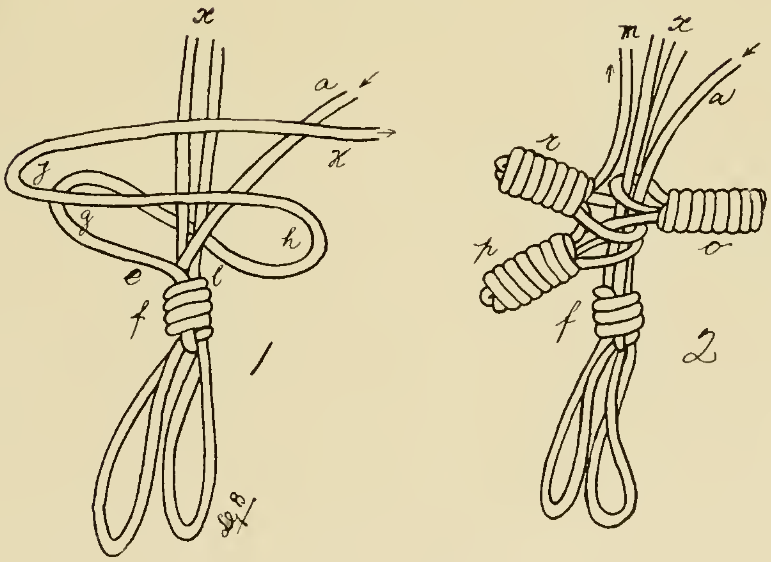

x
a
k
j
g
h
e
l
f
1
m
x
a
r
o
p
f
2

FIG. 141. HANAI G.

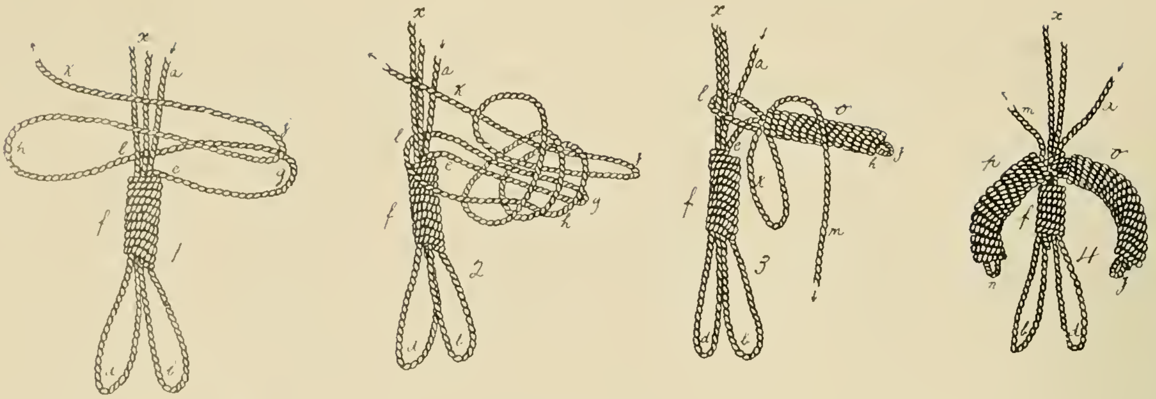


FIG. 142. HANAI H.

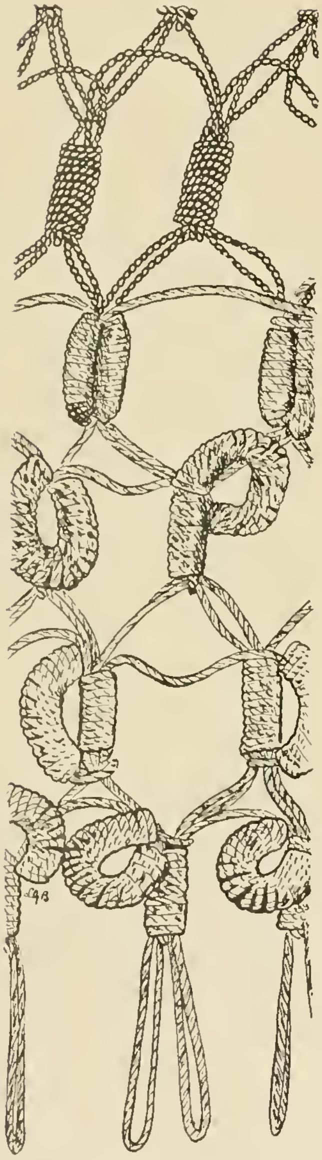


FIG. 143. HANAI H.

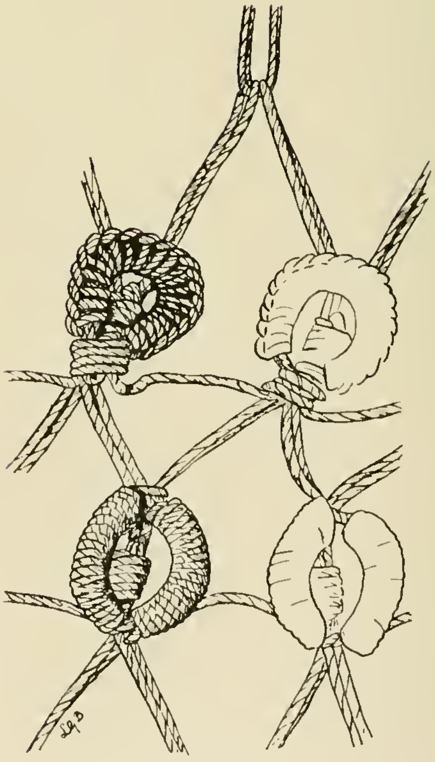


FIG. 144. HANAI H+J.

aipuupuu. An old fisherman claimed that by the creak of the koko on the umeke as the aipuupuu walked, the people could tell when the koko of a chief were approaching.

Tyerman and Bennet referred to this custom:[42] "So stately, too, was the royal etiquette, during his reign [Kamehameha I] that whoever happened to meet the king's calabash of water, as it was brought from the spring to the house, was required to unrobe, and lie down upon the earth, till the bearer of the vessel had gone by."

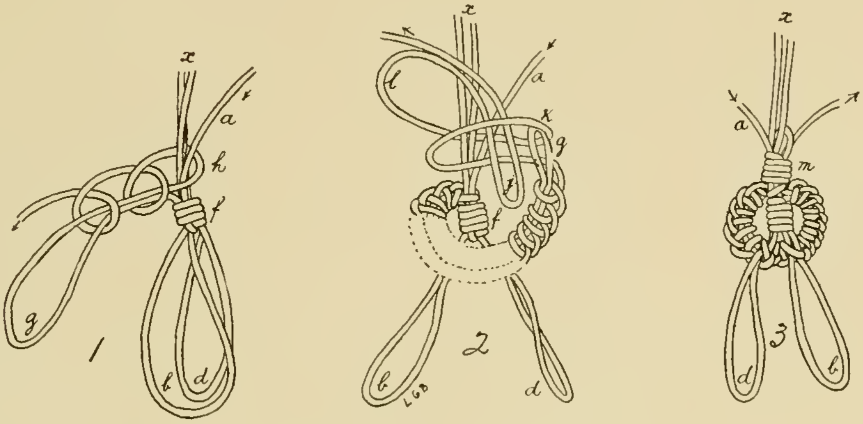


FIG. 145. HANAI J.

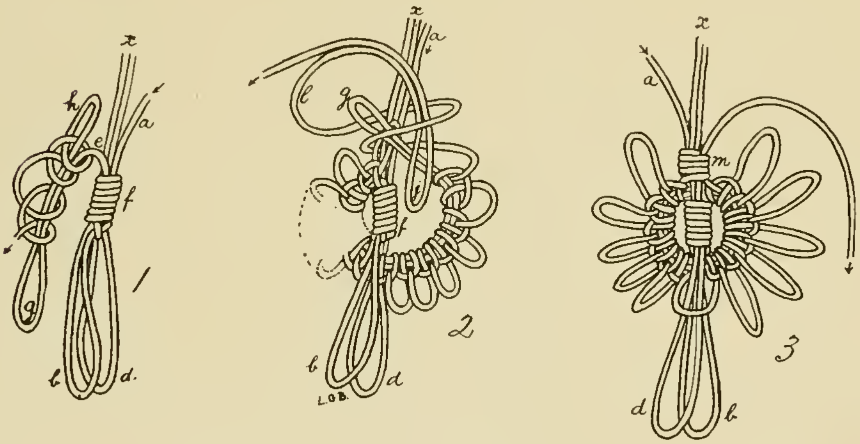


FIG. 146. HANAI K.

In Andrews' Hawaiian Dictionary, a definition of the word *maoloha* occurs as: "The ancient name of the strings or net for a calabash, equivalent to the modern word koko." Natives were questioned about any knowledge of maoloha in these days, and one old fisherman said that koko makalii or koko maoloha existed before the time of Kamehameha the First, but were now no longer; that the name was now applied to the koko carried by the man in the moon. David Malo, in his account "Moolelo

---

[42] James Montgomery; Journal of Tyerman and Bennet, Vol. II, p. 69. Boston, 1832.

Hawaii,"[43] refers to the koko of Maoloha as being connected with the ceremonies of the Makahiki festival. Following the end of the services, he says: "A net [koko] with large meshes was then made, which, being lifted by four men supporting it at four corners, was filled with all kinds of food, such as taro, potatoes, breadfruit, bananas, cocoanuts, and pork, after which the priests stood forth to pray. When the kahuna [priest] in his prayer uttered the word hapai (lift) the men lifted the net and shook it back and forth, to make the food drop through the meshes, such being the purpose of the ceremony. This was called the net of Maoloha. If the food did not drop from the net, the kahuna declared there would be a famine in the land; but if it all fell out he predicted that the season would be fruitful."

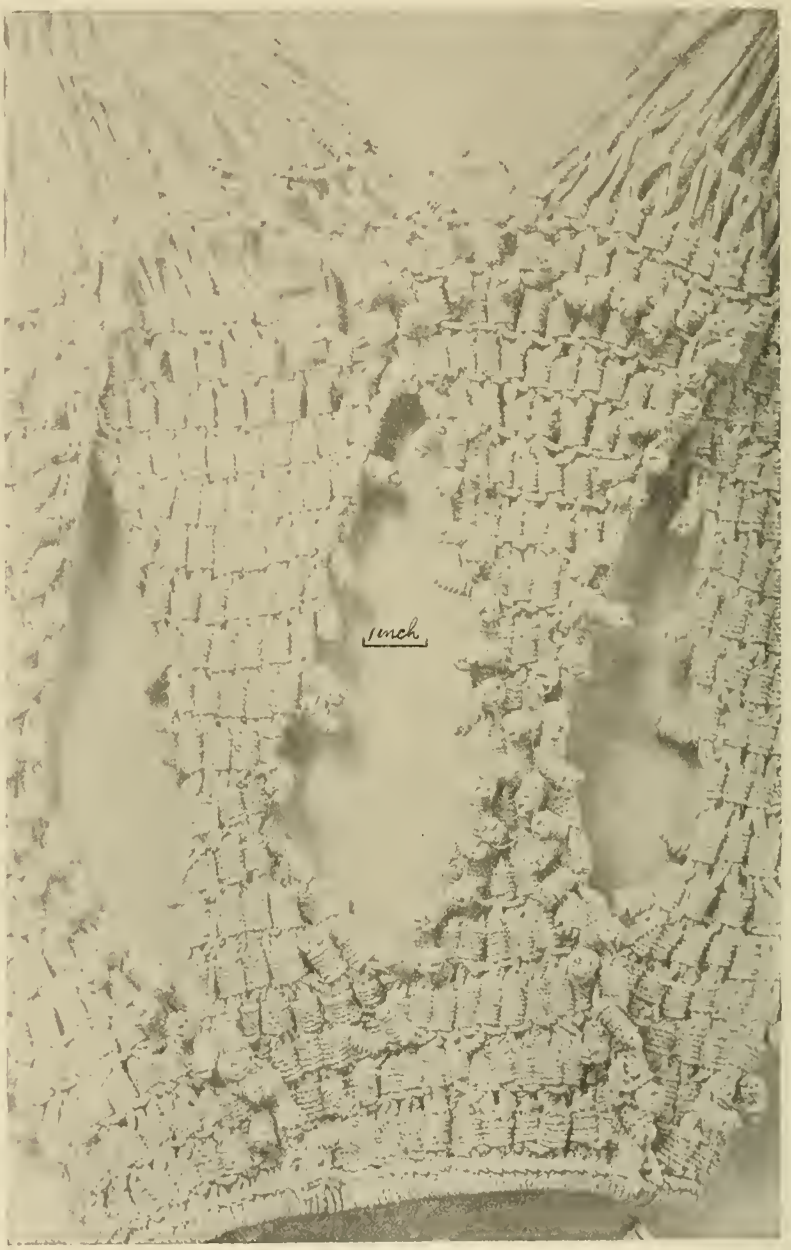


FIG. 147. HANAI L.

Dr. Emerson adds the following interesting note to his translation:—"*Koko a Maoloha*, the net of Maoloha. The expression is used *Ke koko a Maoloha i ka lani.* Tradition says that the first appearance of the Koko of Maoloha was in time of famine, when Waia was king on Hawaii.

---

[43] Hawaiian Antiquities (Moolelo Hawaii) by David Malo, Translated from the Hawaiian by Dr. N. B. Emerson. Honolulu, 1903. p. 197.

In view of the famine that distressed the land, Waia, who was a *kupua*, possessed of superhuman powers, let down from heaven a net whose four corners pointed to the North, South, East and West, and which was filled with all sorts of food, animal and vegetable. This done he shook the net and the food was scattered over the land for the benefit of the starving people." Also:[44] "Apropos of the net of *Maoloha*, at the time the net was filled with food and shaken, the following responsive service, called ka pule koko, the prayer of the net, was celebrated. The net is lifted and the kahuna opens the service saying:—

1.	E uliuli kai, e Uli ke akua e!	Oh deep-blue sea, Oh god Uli!
2.	E uli kai hakoko!	Oh blue of the wild, tossing sea!
3.	Koko lani e Uli!	Net of heaven, oh Uli.
4.	Uli lau ka ai a ke akua.	Green are the leaves of God's harvest fields.
5.	Piho lani koko; e lu—!	The net fills the heavens—Shake it!

"Then the people respond:—

6.	E lu ka ai a ke akua!	Shake down the god's food!
7.	E lu ka lani!	Scatter it oh heaven!
8.	He kau ai keia.	A season of plenty this.
9.	E lu ka honua!	Earth yield up thy plenty!
10.	He kau ai keia.	This is a season of food.
11.	Ola ka aina!	Life to the land!
12.	Ola ia Kane,	Life from Kane,
13.	Kane ke akua ola.	Kane the god of life.
14.	Ola ia Kanaloa!	Life from Kanaloa!
15.	Ke akua kupueu.	The wonder-working god.
16.	Ola na kanaka!	Life to the people!
17.	Kane i ka wai ola, e ola!	Hail Kane of the water of life! Hail!
18.	Ola ke alii Makahiki!	Life to the king of the Makahiki!
19.	Amama, ua noa.	Amama. It is free.
Kahuna:	Noa ia wai?	Free through whom?
People:	Noa ia Kane.	Free through Kane.

"Then the kahunas stand up holding their hands aloft, and the people exclaim: 'Ua noa. Ua noa. Ua noa.' At the same time holding up the left hand, and at the utterance of each sentence, striking with the right hand under the left arm-pit.

"When the kahuna utters the words '*E lu*'—in the 5th line—those who are lifting the net shake it and make its contents fall to the ground."

A legend called the "Koko a Makalii" was narrated to the writer by a Hawaiian repository for such and is here repeated in brief: "Kane, the highest god in the Hawaiian pantheon, had connection with a woman on earth and became the father of Makalii. During a time of severe drought, the people made prayers and offerings to Kane for rain, which were disregarded by the deity. Then Makalii, grieving for the starving people, declared that he would go to his father and demand rain. Provided with koko of exceeding fine mesh[45] he approached the Polynesian Jove, who welcomed his son and filled the koko with water. When Makalii returned to earth the water dropped through the meshes of the koko and fell as rain."

---

[44] Ibid, p. 204-6.

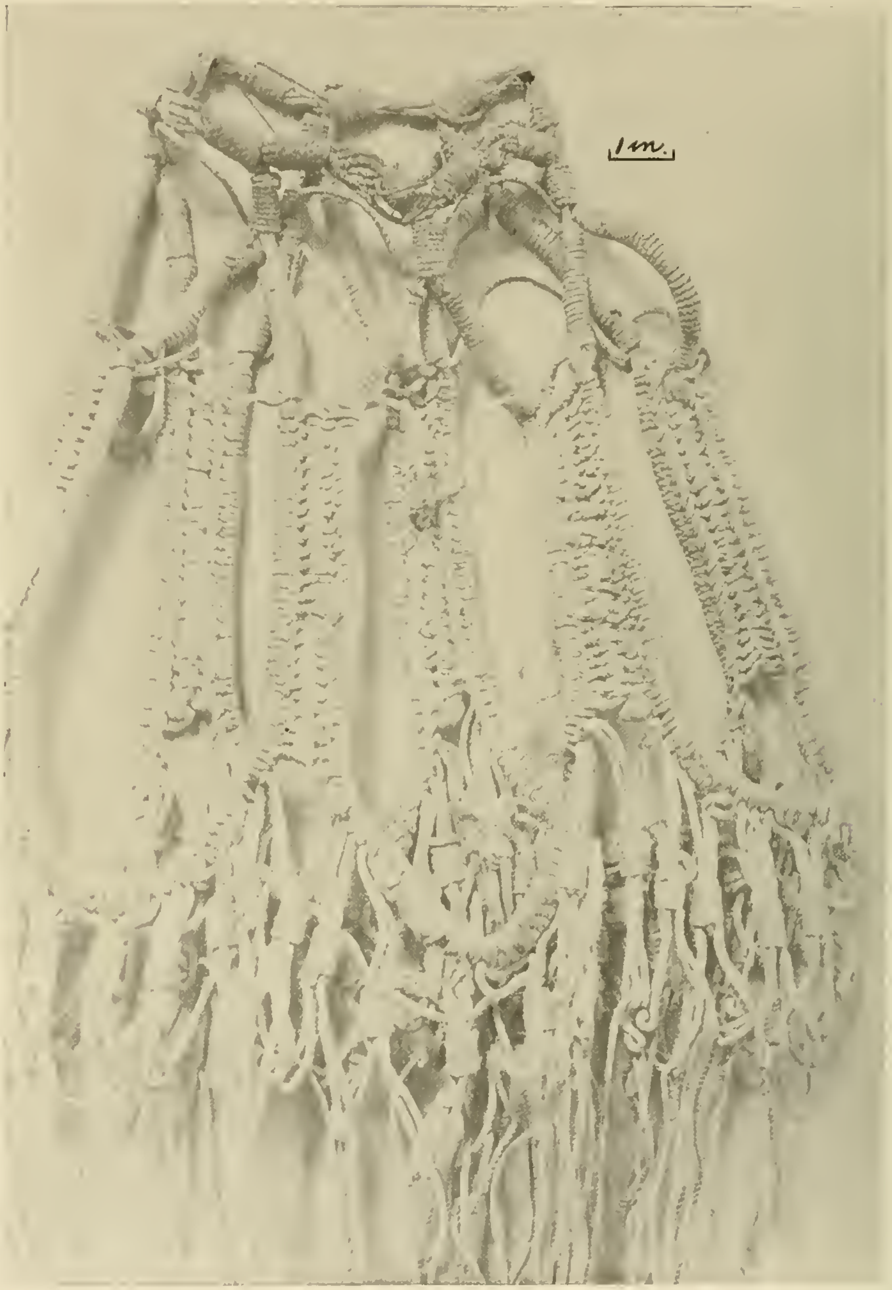


FIG. 148. HANAI M.

It is probable that the two accounts refer to the same thing, as the pule koko recorded by Dr. Emerson would fit the Koko a Makalii, if anything, better than the Koko a Maolola. As far as known, no such net as that used in the ceremonies has ever been preserved. There may have been a service at the end of the makahiki festival somewhat similar to that described by Malo in commemoration of Makalii's daring and beneficial act, but Malo's account is so nearly parallel with that of Peter's vision[46] that the two must have been confused. At the time of Malo's conversion to the Christian religion he was considered exceptionally well versed in native traditions, but following the change he became an ardent but narrow Christian, unable to distinguish between good or bad in the native lore, and condemning the whole as evil. While his mind overflowed with biblical accounts, he wrote his "Moolelo Hawaii," so that it would be quite natural for a bible story to occasionally creep into his relations.

---

[45] Maka = mesh, and lii = small.

[46] Acts, 10; 11, 12.

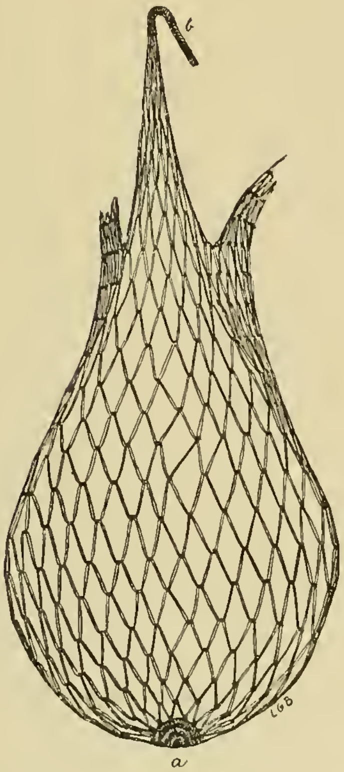


FIG. 149.

In the following lists of koko in the Museum, the measurements are given in inches. The length mentioned is only that of the hanai and piko combined, the kakai being about as long again. The pu of the kakai is uo unless specified otherwise. A comparison of the size of the knot or puu with the mesh will give an idea as to the closeness of some of the netting, and it is quite probable that those koko with the very fine mesh were used as eke, as such are generally accompanied with a piko, the ring of which is very small.

KOKO PUALU.

4423. Ahuawa; Piko A, Hanai C; length 21, mesh 2.2; kakai, pu lino; heavy cord.
4424. Coir; Piko A, Hanai C; length 19, mesh 3.4; rope.
4425. Ahuawa; Piko D (small), Hanai C; length 22, mesh 2.9; kakai, pu lino; heavy cord.
4426. Coir; Piko E, Hanai A; length 30, mesh 9; kakai, pu lino; rope.
4427. Coir; Piko A (small, diam. 1), Hanai C; length 16, mesh 4.8; heavy cord.
4428. Coir; Piko A, Hanai C; length 30, mesh 8; heavy cord.
4429. Coir; Piko E, Hanai A; length 14, mesh 5; kakai, pu lino.
4430. Coir; Piko E, Hanai A; length 17, mesh 5.5; kakai, pu lino.
4431. Coir; Piko E, Hanai A; length 18, mesh 5.5; kakai, pu lino.
4432. Coir; Piko E, Hanai A; length 14.5, mesh 5.5; kakai, pu lino.
4433. Coir; Piko E, Hanai A; length 19, mesh 6.6.
4434. Coir; Piko D, Hanai A; length 12, mesh 3.1.
4435. Coir; Piko D, Hanai A; length 12.5, mesh 3.3.
4436. Coir; Piko D, Hanai A; length 13, mesh 3.2.
4437. Coir; Piko E, Hanai A; length 27, mesh 9.5; no kakai; heavy cord.
4438. Coir; Piko E, Hanai A; length 18, mesh 5; kakai without pu.
4439. Hau; Piko C, Hanai A; length 16, mesh 7.3.
4440. Coir; Piko D, Hanai A; length 18.5, mesh 5.7.
4441. Coir; Piko D, Hanai A; length 18, mesh 5.2.
4442. Coir; Piko C, Hanai A; length 13, mesh 4.3; heavy cord. Fig. 114.

4448. Oloná; Piko C, Hanai A; length 20.5, mesh 7.5.
4449. Waoke; Piko A, Hanai A; length 12, mesh 5; kakai, pu lino.
4450. Waoke; Piko C, Hanai A; length 7.5, mesh 1.6.
4452. Cotton cord; Piko D, Hanai A; length 6.5, mesh 4.
4453. Waoke; Piko D, Hanai C; length 12.5, mesh 3.5.
4463. Coir; Piko B, Hanai A; length 12, mesh 1.2; no kakai.
6859. Coir; Piko C, Hanai A; length 17, mesh 5.6.
9017. Hau; Piko E, Hanai A; length 8, mesh 4.5.
9018. Coir; Piko A, Hanai C; length 15, mesh 4.5.
9019. Coir; Piko C, Hanai C; length 23, mesh 8.
9020. Coir; Piko A, Hanai C; length 29, mesh 7.5; heavy cord.

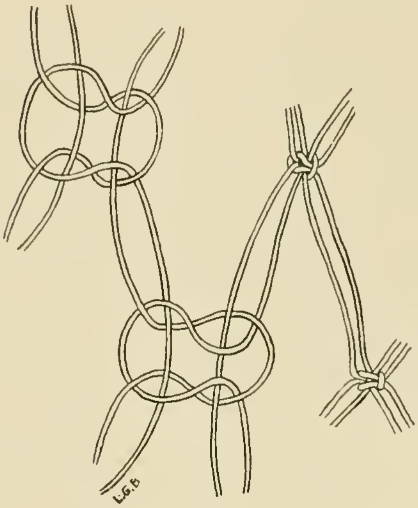


FIG. 150.

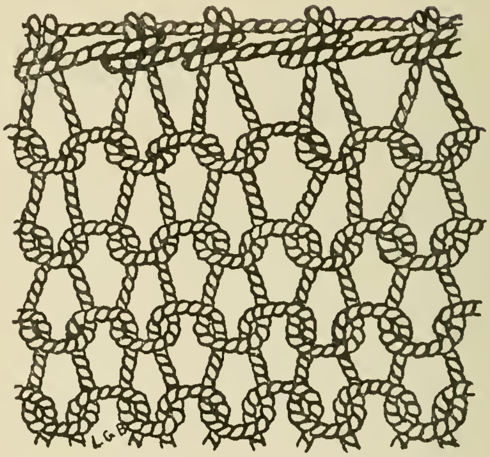


FIG. 151. HANAI OF PLAIN KNITTING.

9021. Coir; Piko D, Hanai C; length 14, mesh 4.5.
9022. Coir; Piko E, Hanai A; length 30, mesh 10.2–11.8; heavy cord.
9023. Coir; Piko E, Hanai A; length 22, mesh 9.2.
9024. Coir; Piko D, Hanai A; length 17.5, mesh 4.5.
9025. Coir; Piko D, Hanai A; length 17, mesh 3.8.
9026. Coir; Piko E, Hanai A; length 16.5, mesh 6.5; kakai, pu lino.
9027. Coir; Piko D, Hanai A; length 14, mesh 3.
9028. Coir; Piko E, Hanai A; length 15.5, mesh 6.2; kakai, pu lino.
9029. Coir; Piko D, Hanai A; length 14, mesh 4.3.
9049. Coir; Piko E, Hanai A; length 20, mesh 6; heavy cord.
L 196. Hau; Piko E, Hanai A; length 11, mesh 6.
L 197. Coir; Piko D, Hanai C; length 23, mesh 12.
L 198. Coir; Piko E, Hanai A; length 16, mesh 11.5; kakai, pu lino.
L 394. Coir; Piko E, Hanai A; length 10.5, mesh 6.7.
L 395. Coir; Piko D, Hanai C; length 13, mesh 13.
L 396. Coir; Piko E, Hanai A; length 14.5, mesh 9.

KOKO PUUPUU.

3070. Onionio, coir and horsehair; Piko N, Hanai D; length 16.5, mesh 3.2; puu 1 inch long.

3071. Onionio, coir and horsehair; Piko N, Hanai D; length 16, mesh 3, puu 1.

4346. Waoke; Piko J roughly made, Hanai G with 2 puu; length 17.5, mesh 3.2, puu 1.2.

4347. Pauku, coir and waoke; Piko F, Hanai D; length 13, mesh 2.3, puu .5; no kakai.

4348. Pauku, coir and olońa; Piko D (small, .6 diam.), Hanai B+D; length 24 (16+8), mesh 4+1.7, puu .3+.5; no kakai.

4349. Waoke; Piko N (27 in circumference), Hanai H with 3 puu; length 16.5, mesh 6, puu 1.8.

4350. Waoke; Piko F, Fig. 122, Hanai D; length 13, mesh 1.8, puu .8.

4351. Waoke; Piko N, Hanai G with 3 puu, Fig. 131; length 15, mesh 4.5, puu .7.

4352. Waoke; Piko N, Hanai G with 3 puu; length 12, mesh 3.5, puu .5; no kakai.

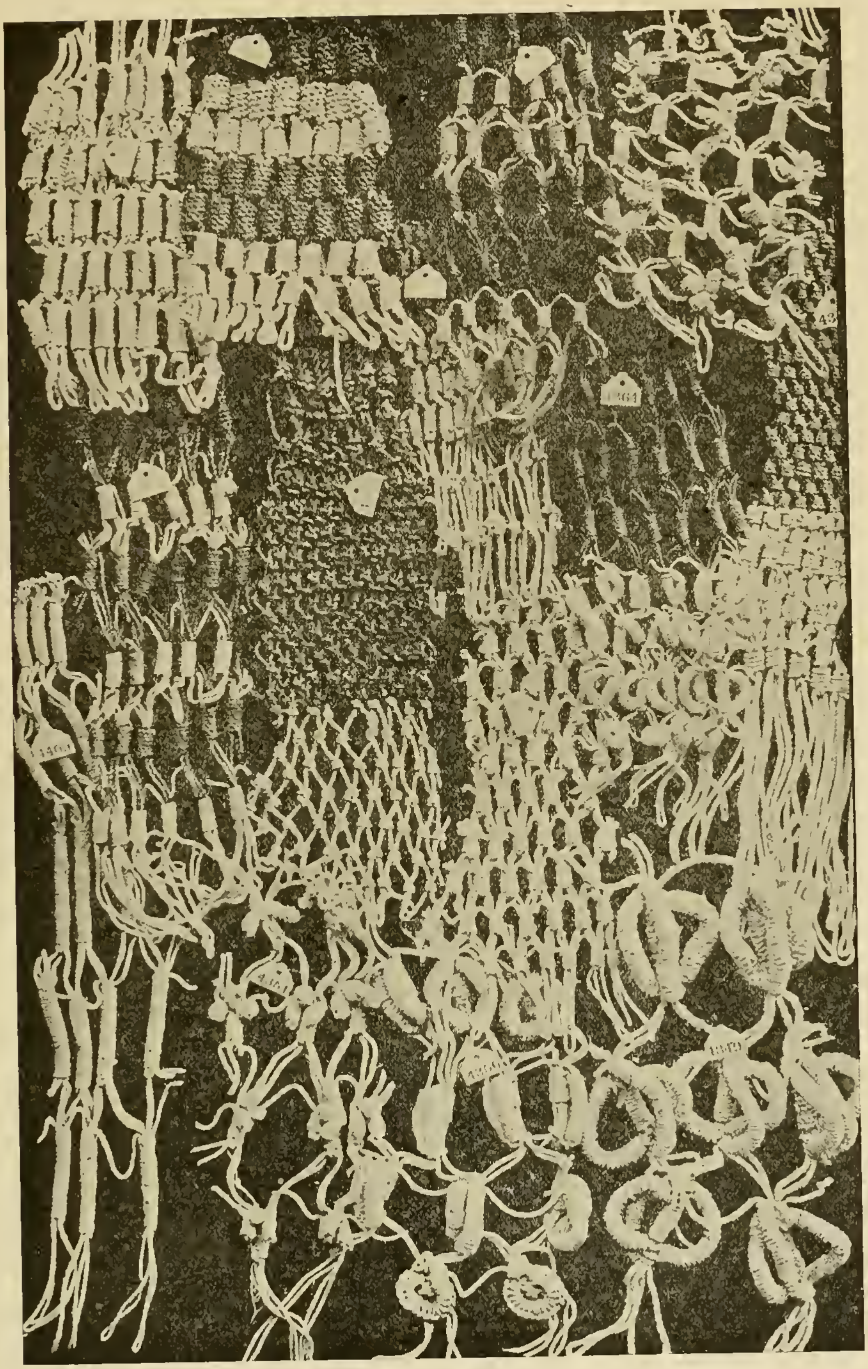


FIG. 152. SAMPLES OF KOKO.

4353. Waoke; Piko N (24 in circ.), Hanai G with 3 puu; length 12, mesh 2.1, puu .6.

4354. Waoke; Piko N (large), Hanai G with 3 puu; length 11.5, mesh 1.5, puu .6.

4355. Waoke; Piko H, Hanai G with 1 puu; length 16, mesh 2, puu .6. Fig. 105 c; koko inverted.

4356. Oloná; Piko N, Hanai H+J, Fig. 144; length 15.5, mesh 5.7, puu .6.

4357. Oloná; Piko N, Hanai M; length 14.2. Fig. 148.

4358. Oloná; Piko F, Hanai L; length 15, mesh .8, puu .4. Fig. 147.

4359. Pauku, coir and waoke; Piko C, Hanai B; length 15, mesh .6, knot .4; no kakai.

4360. Pauku, coir and waoke; Piko D (.6 diam.), Hanai B; length 21.5, mesh .4, knot .2.

4361. Pauku, coir and waoke; Piko O, Hanai D; length 9, mesh .8, puu .7; damaged, no kakai.

4362. Pauku, coir and waoke; Piko O, Hanai D; length 12, mesh .5+1.5, puu .5+.6.

4363. Oloná; Piko N (27 in circumference), Hanai K; length 21, mesh 2.8. Fig. 105 d; koko inverted.

4364. Pauku, coir and waoke; Piko F, Hanai D + H, Fig. 143; length 14, mesh 2.5, puu .6; no kakai.

4365. Pauku, coir and waoke; Piko A, Hanai A+B; length 13, mesh .3+1; kakai with 1 pu no bound together at the two ends. Fig. 134.

4366. Pauku, coir and waoke; Piko O (1 diam., Fig. 133), Hanai D; length 20, mesh .7–2.3, puu .6–1.8; no kakai.

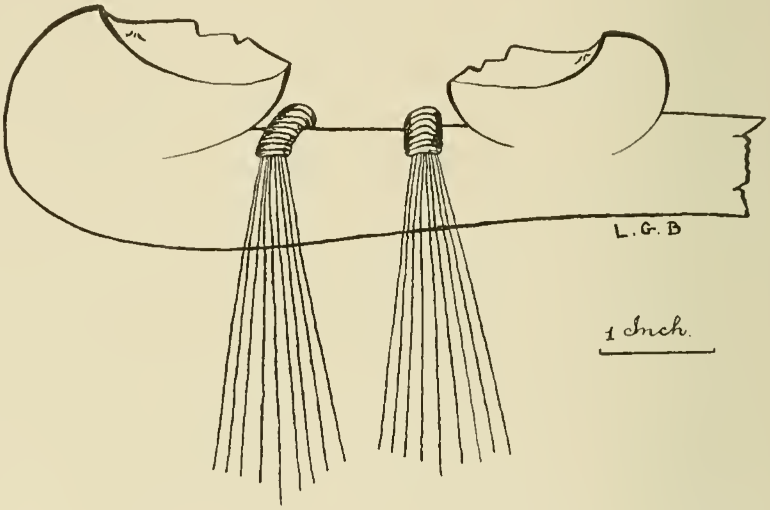


FIG. 153. END OF AUAMO SHOWING PU UO.

4367. Pauku, coir and waoke; Piko F (18 in circumference), Hanai D; length 14, mesh 1–1.4, puu .6–.8; no kakai.

4368. Pauku, coir and waoke; Piko O, Hanai D; length 17, mesh .6–2.4, puu .5–1.4.

4369. Pauku, coir and waoke; Piko K, Hanai D; length 11.5, mesh 2.5, puu .6.

4370. Pauku, coir and waoke; Piko N, Hanai D; length 21.5, mesh 3.3, puu .4–.8.

4371. Pauku, coir and waoke; Piko F, Hanai D; length 15.5, mesh 2.5–3.2, puu .6–.8.

4372. Pauku, coir and waoke; Piko F, Hanai D; length 13.5, mesh 3, puu .9–1.4; no kakai.

4373. Pauku, coir and waoke; Piko N, Hanai D; length 20.5, mesh 2.3, puu .6.

4374. Pauku, coir and waoke; Piko N, Hanai D; length 25, mesh 3.4, puu .7.

4375. Pauku, coir and waoke; Piko N, Hanai D; length 12.2; mesh 2.4, puu .7.

4376. Pauku, coir and waoke; Piko F, Hanai D; length 11, mesh 2.1, puu .4; no kakai.

4377. Pauku, coir and waoke; Piko N, Hanai D; length 15, mesh 3.1, puu .7; no kakai.

4378. Pauku, coir and waoke; Piko J, Hanai D; length 15, mesh 2.9, puu .8; no kakai.

4379. Pauku, coir and waoke; Piko J (21 in circumference), Hanai D; length 13, mesh 4, puu .8.
4380. Pauku, coir and waoke; Piko F, Hanai D; length 17, mesh 2.4, puu .8; no kakai.
4381. Pauku, coir and waoke; Piko N, Hanai D; length 18, mesh 3, puu .7; no kakai.
4382. Pauku, coir and waoke; Piko N, Hanai D; length 13, mesh 2.8, puu .7.
4383. Pauku, coir and waoke; Piko N, Hanai D; length 12, mesh 2.7, puu .7.
4384. Pauku, coir and waoke; Piko N, Hanai D; length 15.5, mesh 3.2, puu .8.
4385. Onionio, coir and waoke; Piko F, Hanai D; length 14, mesh 2.1, puu .8.
4386. Oloná; Piko F, Hanai D; length 22, mesh 5–6.5, puu .9–1.1.
4387. Waoke; Piko F, Hanai D; length 20, mesh 1.8–2.5, puu .6.
4388. Waoke; Piko M, Hanai D; length 9.6, mesh 1.3, puu .4.
4389. Oloná; Piko G, Hanai D; length 11, mesh 2.3, puu .8.
4390. Waoke; Piko F, Hanai D; length 14.5, mesh 2, puu .5.
4391. Waoke; Piko F, Hanai D; length 10.5, mesh 2, puu .6.
4392. Waoke; Piko F (1 in diam.), Hanai D; length 15.5, mesh 2, puu .9; no kakai.
4393. Waoke; Piko N, Hanai D; length 10.5, mesh 1.8, puu .8.
4394. Oloná; Piko G, Hanai D; length 17, mesh 1.6, puu 7.
4395. Waoke; Piko K, Hanai D; length 10, mesh 1.7, puu .5.
4397. Oloná; Piko F, Hanai D; length 13, mesh 3.1, puu 1.3.
4398. Waoke; Piko F (1.2 diam.), Hanai D; length 10.5, mesh 2.3, puu .9.
4399. Waoke; Piko F, Hanai D; length 10, mesh 1.9, puu .9; no kakai.
4400. Waoke; Piko H (.6 in diam.), Hanai D; length 15.5, mesh 3.5, puu .7; no kakai.
4401. Waoke; Piko F, Hanai D; length 14.5, mesh 4.6, puu .6–.8.
4402. Waoke; Piko A (.8 in diam.), Hanai D; length 14.5, mesh 3, puu .6.
4403. Oloná hanai and waoke kakai; Piko F, Hanai D; length 14, mesh 2.8, puu 1.1.
4404. Oloná; Piko F, Hanai D; length 8.5, mesh 2.7, puu .4.
4405. Oloná; Piko G, Hanai D; length 12.5, mesh 2.6, puu .8.
4406. Waoke; Piko K, Hanai D; length 12, mesh 2.1, puu .7.
4407. Waoke; Piko K, Hanai D; length 11, mesh 2.1, puu .7.
4408. Oloná; Piko F, Hanai D; length 23, mesh 8, puu .8.
4409. Waoke; Piko F, Hanai D; length 17, mesh 3.7–4, puu 1.5–2.2 long and thin; no kakai.
4410. Onionio, coir and waoke; Piko H, Hanai D; length 12, mesh 1, puu .7; no kakai.
4411. Onionio, coir and waoke; Piko N, Hanai D; length 17.5, mesh 3, puu .6–.7; no kakai.
4413. Pauku, coir and waoke; Piko N, Hanai D; length 9, mesh 2.8, puu .5.
4414. Onionio, coir and waoke; Piko N, Hanai D; length 13.5, mesh 2.8, puu .7.
4415. Pauku, coir and waoke; Piko N, Hanai D; length 14, mesh 3, puu .9.
4416. Onionio, coir, waoke and horsehair; Piko N, Hanai D; length 15.5, mesh 2.7, puu. 8.
4417. Pauku, coir and waoke; Piko N, Hanai D; length 15.5, mesh 2.9, puu .8.
4418. Onionio, coir, waoke and horsehair; Piko F, Hanai D; length 11, mesh 2.1, puu .6; no kakai.
4419. Waoke; Piko F, Hanai D; length 9.2, mesh 2.3, puu .7.

4420. Onionio, coir and waoke; Piko E, Hanai B; length 14.5, mesh 3.

4421. Pauku, coir and waoke; Piko A, Hanai B; length 10.5, mesh 2.3.

4444. Pauku, coir and waoke; Piko D (?), Hanai B; length 17, mesh 4.3, knot .5; modern looking.

4445. Pauku, coir and waoke; Piko A, Hanai A; length 19; mesh 3.

4446. Pauku, coir and waoke; Piko D, Hanai B; length 16.5; mesh 5.5.

4447. Pauku, coir and waoke; Piko B, Hanai B; length 19, mesh 4.7, knot .4.

4456. Waoke; Piko F, Hanai E; length 21, mesh 3.5–5, puu .5. Fig. 105 *a*.

4457. Pauku, coir and waoke; Piko N, Hanai D; length 12, mesh 2.7, puu .8.

4458. Pauku, coir and waoke; Piko N, Hanai D; length 17, mesh 2.5, puu .7.

4459. Waoke; Piko N, Hanai D; length 10, mesh 2.4, puu .5.

4460. Pauku, coir and waoke; Piko N, Hanai D; length 13, mesh 2.5, puu .7.

4461. Waoke; Piko J (Fig. 126), Hanai D; length 10, mesh 2.4, puu .7.

4462. Pauku, coir and waoke; Piko F, Hanai D; length 9.5, mesh 2, puu .5.

4464. Waoke; Piko F, Hanai D; length 12, mesh 1.4–2.3, puu .9. Figs. 120, 121.

4465. Waoke; Piko F, Hanai D; length 13.5, mesh 1.7, puu .9.

5324. Coir; Piko O, Hanai D; length 8.4, mesh 1.1–1.3, puu .6–1; fragment, lower two-thirds only.

6857. Waoke; Piko F, Hanai E; length 20, mesh 4.2, puu .4. Fig. 104 *a*.

6858. Waoke; Piko F, Hanai D; length 8.8, mesh 2.2, puu .3.

7703. Waoke; Piko L, Hanai F; length 15, mesh 3, puu .6. Fig. 115.

7706. Pauku, coir and waoke; Piko F (.6 diam.), Hanai B; length 16, mesh .8.

7707. Waoke; Piko F, Hanai D; length 15, mesh 1.7, puu .6; no kakai.

7708. Pauku, coir and waoke; Piko D (.4 diam.), Hanai B; length 21, mesh .8; no kakai.

7748. Pauku, coir and waoke; Piko F (1 diam.), Hanai D; length 15, mesh 2.3, puu .6.

7966. Waoke; Piko N, Hanai D; length 15, mesh 2.5, puu .8.

9013. Waoke; Piko K, Hanai D; length 10.5, mesh 2, puu .8.

9014. Pauku, coir and waoke; Piko N, Hanai D; length 15, mesh 2, puu 1.

9015. Onionio, coir, waoke and horsehair; Piko N, Hanai D; length 17, mesh 3, puu 1.

9016. Waoke; Piko N, Hanai G with 3 puu; length 13, mesh 3, puu .4.

9050. Waoke; Piko F, hanai of plain knitting; length 6.9, mesh .3.

L 92. { Pauku, coir and waoke; Piko O, Hanai D; length 10.5, mesh .5–1.5, puu .4–1.1.
Oloná; Piko F (large), hanai of plain knitting (Fig. 151); length 12.5, mesh .4.

L 194. Pauku, coir and waoke; Piko D (.3 diam.), Hanai B; length 15, mesh .5, knot .3; kakai in four parts.

L 195. Pauku, coir and waoke; Piko N, Hanai D; length 17, mesh 3, puu 1.

L 397. Coir; Piko F, Hanai D; length 9, mesh 2.5, puu .8; fragment, no kakai.

KOKO EKE.

4422. Cotton cord; Piko (?), hanai, foreign knot, probably Chinese; length 20, mesh 4.2.

4451. Waoke; Piko D, Hanai C; length 12.7, mesh 3.5; kakai, a double draw string. Fig. 136.

9051. Waoke; Piko D, Hanai C; length 11.8, mesh 5; kakai, draw string.

MISCELLANEOUS.

4454. Foreign koko; length 37.5, mesh 2.2. Figs. 149 and 150.
4455. Foreign koko; black woolen braid; knot, Fig. 150; length 20, mesh 2.6.

Aha.—Of the aha[47] or cords surrounding and permanently fastened to gourd water bottles (huewai, olowai, etc.) the most common was that known as *hawele*—sometimes referred to as koko hawele—and shown in Fig. 106 enclosing a huewai. There is in the collection a great number of drinking and other gourd vessels without cordings which would have been carried in koko puupuu or pualu. The huewai was a drinking gourd of large body and narrow neck for general use. The variety of forms of gourd vessels was very great, and was generally the result of manipulation when the fruit was green.

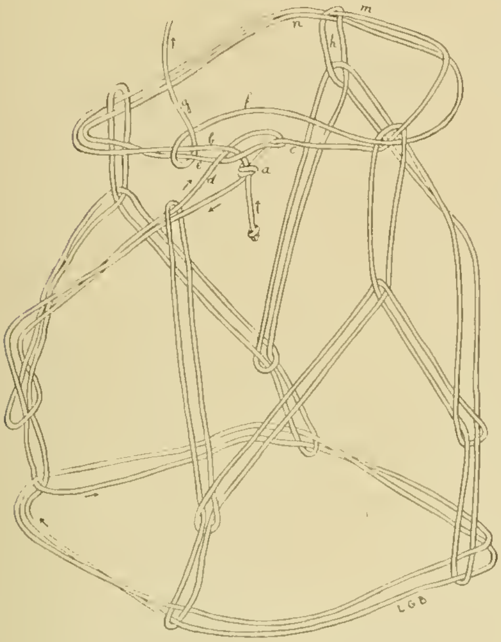


FIG. 154. DETAIL OF AHA HAWELE.

The word hawele means a tying or binding on in which the joinings or loops are never knotted, and the koko or aha hawele may be so recognized. Details of technique of the aha hawele in Fig. 106 will be seen in Fig. 154, where, after a loop, *b m c*, is made round the neck of the bottle and tied at *a*, the cording continues in the direction indicated. There is a slight error, for which the writer is responsible, in the drawing, for the cord *f*, instead of encircling *b* and *c*, should pass under and over *a* and *d* and under itself. A bail is then made by carrying *g* over the top of the bottle, over *m*, under *h*, over *n* and back around *a* and *d*. When there are four or five thicknesses of cord in the bail, it is bound at several points with half hitches by the end of *g*, the latter being finally fastened to the wooden or shell stopper. The material used was coir, spun or braided—seldom oloná or hau. A similar lashing, but more complex, was noticed on a gourd water bottle, No. 1931, from New Caledonia.

A very neat fastening of the aha hawele has been made around a huewai pueo (Fig. 155) which is a water gourd shaped like an hour glass. In the figure, when the aha hawele, as shown in Figs. 106 and 154, was attached to the lower bulb, to its upper cords another binding was added for the purpose of enclosing the other part. However, in a great number of the pueo with hawele the lower bulb is alone corded and the bail fastened to the waist. A plain and chaste style of aha hawele was found on an old broken huewai in the collection Fig. 156, the cord of which was more neatly braided than on any of the other specimens. Another form, rarely used, is shown in Fig. 157.

---

[47] Aha should be applied only to (1) coir cord, (2) cord of human hair, (3) strings made from intestines. (See Andrews' Dictionary.) Other cords, such as oloná, should be termed *aho*.

A form of water gourd used in the canoes was called olowai, Fig. 107. The writer has not been able to learn any specific name for the aha on this gourd, and since only two (Nos. 3877 and 3880) out of the five specimens in the collection have aha exactly similar, the probabilities are that each individual followed his own taste in cording. In the aha figured, Fig. 107, the work was done by making two half hitches on the bottom of the gourd, and on the rings thus made four loops of single cord were formed large enough to reach the middle. The cord was then brought to the neck of the bottle and fastened by two half hitches. A set of four loops was attached to these rings, at the same time passing in turn through the bights of the previous set, thus drawing the lashings tightly around the gourd. The cord was then made to follow the cords of each loop and an eye was formed by tying at each bight. The double ring at the middle was added last. For the bail, suspended over the side of the bottle, a separate cord was used. Another aha, on specimen No. 3995, is similar to that in Fig. 107, except for the double ring in the middle. Of the other specimens of corded olowai, one, No. 3879, is enclosed in an aha hawele, and the other, No. 3881, in a large-meshed netting.

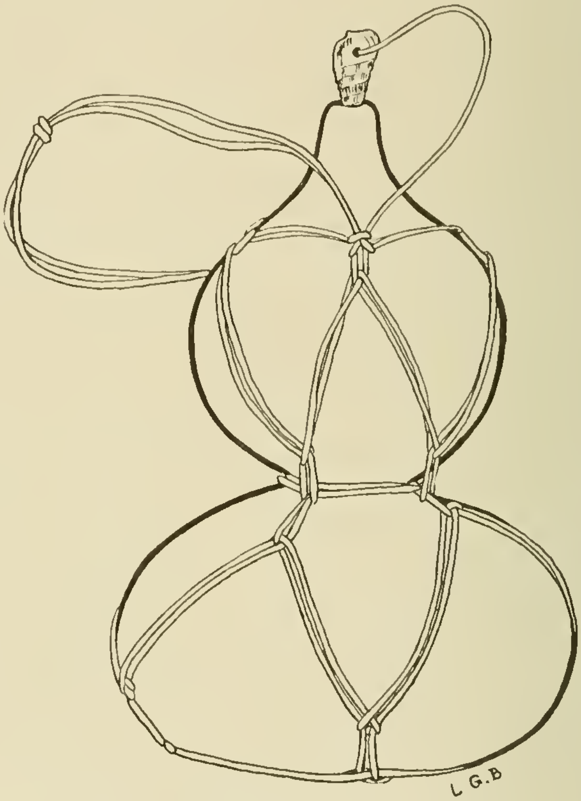


FIG. 155. HUEWAI PUEO WITH AHA HAWELE.

Ipu le'i, *ipu holoholona*, *poho aho* and *ipu aho* are among the names used to designate a utensil, consisting of two pieces, for containing fish hooks and lines. There are two general forms of this article: one with the lower and smaller part of wood covered with a larger gourd, Figs. 158 and 159, and the other of gourd with the lower larger than the upper part, Fig. 160. There is some confusion now as to the correct names and uses of the different styles, but the best information seems to be that the former, called ipu le'i or ipu holoholona, was for the purpose of holding bait in addition to hooks and lines, and the latter, poho aho, for the fishing tools alone. Some of the poho aho were composed of bowl-shaped gourds, and others of long narrow gourds, covered with half a small gourd or coconut.

Similar cordings enclosed both styles, and the most finished in appearance is that around the ipu le'i in Fig. 158. This cording, called koko, or koko ipu le'i, is a combination of the aha hawele firmly fastened around the wooden part, to the upper cords of which a netting is attached to enclose the cover. The netting is closed around the cover by a draw string, which also serves to carry the utensil. In a few specimens the aha hawele has been dispensed with, the netting being fastened through holes bored in the upper edge of the lower part, Fig. 159. This last method was also used on the *hinai poepoe*, which have been treated by Dr. Brigham in the previous portion of this memoir. Another and simpler method of attaching cords to these articles is shown in Fig. 160; here the edge of the lower part has been pierced at two opposite points, from which two cords were led upwards through holes in the cover.

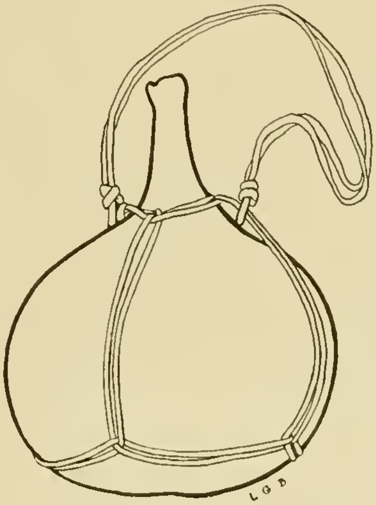


FIG. 156.

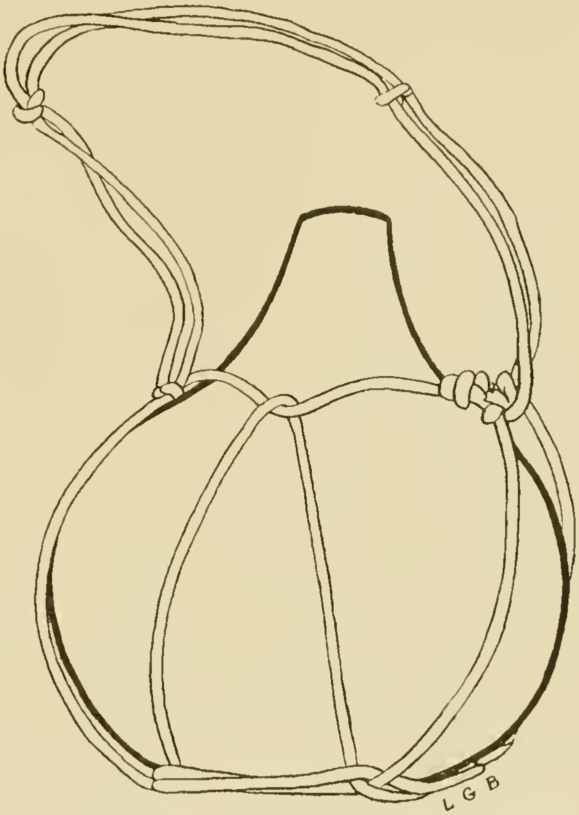


FIG. 157.

HUEWAI WITH AHA HAWELE.

Before passing from the gourd cordings, it might be in order to mention the several means of securing handles to gourds in vogue among the natives. The simplest form noticed is a coir or hau cord around the neck of the huewai, when the mouth of the gourd bulges, Fig. 161*a*; some of the cords were roughly made and tied, but in others the cord has been braided and then attached by a double half hitch. A few of the huewai pueo have also been treated in this manner, Fig. 161 *b*. When the huewai was not pueo or bulged at the mouth, then a handle was sometimes attached by making a hole at the base of the neck and through it drawing and knotting both ends of a loop of coir or hau cord or braid, Fig. 161 *d*, or, by boring the edge of the mouth at two points opposite, through which the ends of a hau or oloná line were passed and knotted. Fig. 161 *c*.

In some of the bowl-shaped gourds, eight holes were pierced in pairs and each end of two cords passed through two of the holes and knotted, Fig. 162. Handles, generally more than two, were so attached to many of the hinai poepoe, and *ieie* and pandanus baskets.

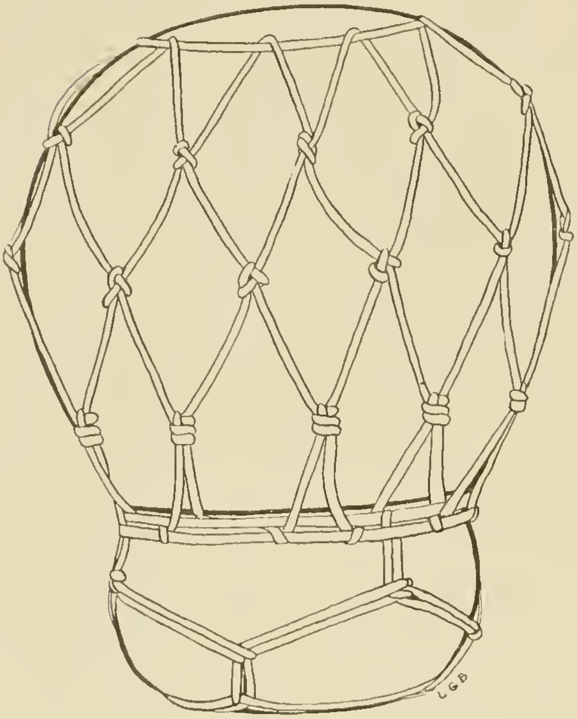


FIG. 158. IPU LEI.

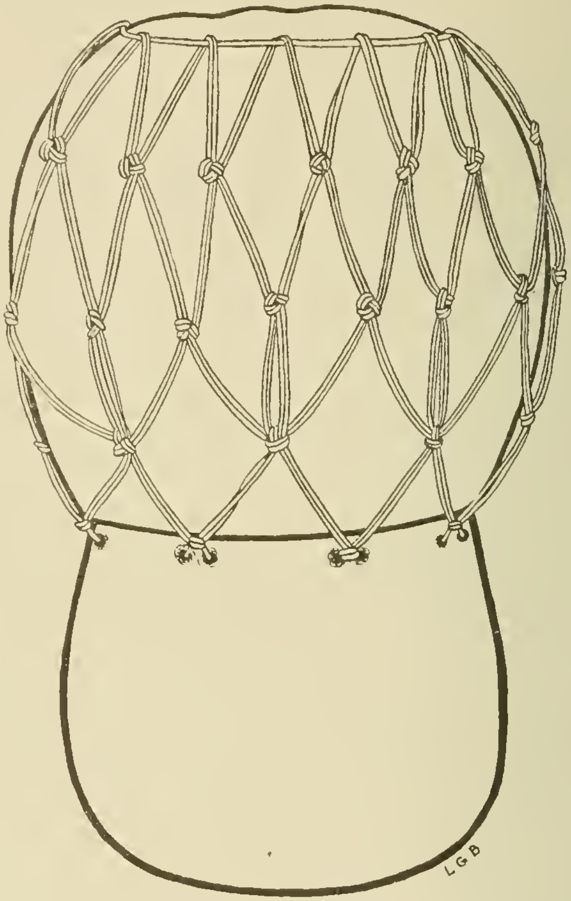


FIG. 159. IPU LEI.

LIST OF GOURD VESSELS, WITH CORDINGS ATTACHED.

1093. Huewai; aha hawele, coir.
1094. Huewai; aha hawele, coir.
1099. Huewai, aha hawele, coir.
1100. Huewai; aha hawele, coir.
1101. Huewai; aha hawele, coir, Fig. 156.
1102. Huewai; aha hawele, cotton cord.
1104. Huewai; aha hawele, coir.
1107. Huewai; aha hawele, coir.
1112. Huewai pueo; aha hawele, coir, Fig. 155.
1113. Huewai pueo; aha hawele, coir.
1114. Huewai pueo; aha hawele, coir.
1121. Huewai; aha hawele, coir.
1122. Huewai; aha hawele, coir.
1124. Huewai; aha hawele, coir.
1128. Huewai; aha hawele, coir.
1129. Huewai; aha hawele, coir, Fig. 106.

1133. Huewai; aha hawele, oloná.
1137. Huewai; aha hawele, coir.
1261. Huewai pueo; aha hawele, coir.
3934. Huewai; aha hawele, hau, Fig. 157.

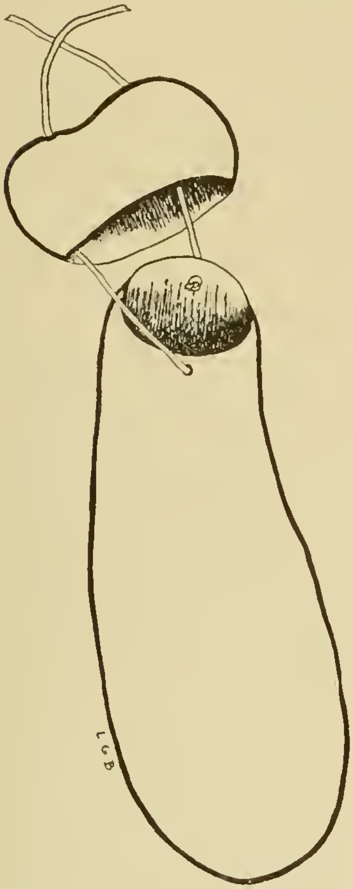


FIG. 160. POHO AHO WITH CORD.

3935. Huewai; aha hawele, coir.
3938. Huewai; aha hawele, hau.
3940. Huewai; aha hawele, coir.
3996. Huewai pueo; aha hawele, coir.
7750. Huewai; aha hawele, hau.
1097. Huewai; coir, Fig. 161 *a*.
1108. Huewai; coir, Fig. 161 *d*.
1109. Huewai; hau, Fig. 161 *c*.
1111. Huewai pueo; coir, Fig. 161 *b*.
3942. Huewai; hau, Fig. 161 *a*.
3944. Huewai; coir, Fig. 161 *a*.

7667. Huewai; oloná, Fig. 161 *d*.
7668. Huewai; coir, Fig. 161 *a*.
3877. Olowai; coir.
3879. Olowai; aha hawele, coir.

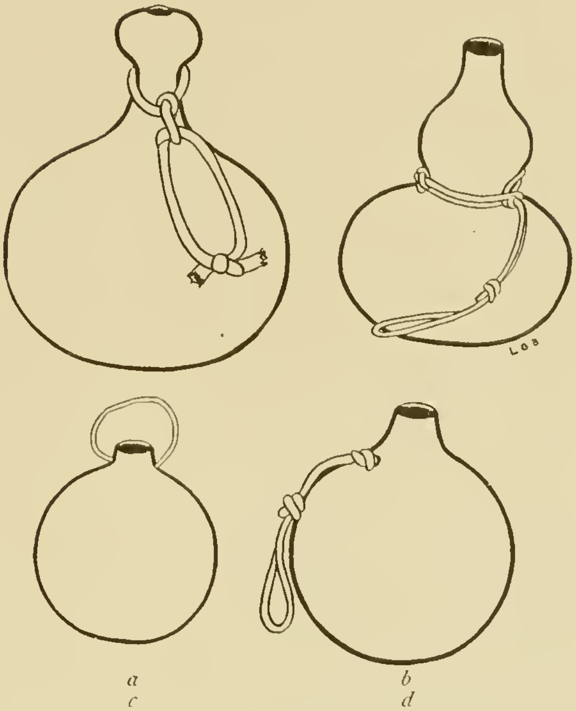


FIG. 161. HUEWAI WITH CORD HANDLES.

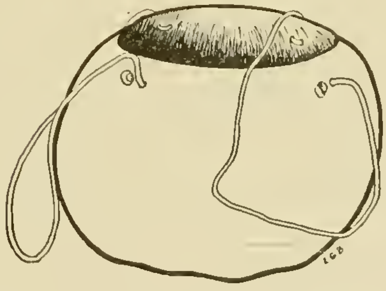


FIG. 162. GOURD UMEKE WITH CORD.

3880. Olowai; coir, Fig. 107.
3881. Olowai; coir, netted.
3995. Olowai; coir.
3951. Umeke; oloná, Fig. 162.
3952. Umeke; oloná.

Ipu Le’i.

3850.	Oloná and coir.
3851.	Hau, coir and oloná.
3852.	Oloná, cords of hawele doubled.
3853.	Oloná.
3854.	Coir.
3855.	Wooden part only, pierced.
3856.	Coir, Fig. 158.
3857.	Coir, Fig. 159.
3858.	Oloná.
3859.	Oloná.
3860.	Hau.
3994.	Coir.

Poho Aho.

3861.	Oloná.
3869.	Oloná.
3870.	Oloná.
3871.	Oloná.
3872.	Oloná.
3873.	Oloná.
3874.	Oloná and coir.
3875.	Oloná, Fig. 160.
3876.	Oloná.
3927.	Coir.
3953.	Oloná.
5027.	Coir.
6373.	Coir.

Nets, Upena.—As the second division of net work, fish nets and similar fabrics for different uses come up for consideration. The material most preferred and used, except where noted below, was oloná spun into cord varying greatly in thickness.

The method of beginning a net is interesting, and has been shown to the writer by fishermen on Oahu and Molokai. The native, having filled his shuttle from the ball of twine without severing the line, takes another cord, Fig. 163 *a a*, the ends of which he ties together. Sitting on the ground with feet far apart, he inserts the first toes into the ring and stretches it tightly. The ball is passed under and over *a a* three times towards the right, and the friction on the cords is sufficient to keep the line *c* taut while closing the knots. Then the shuttle is passed around the gauge, over *a a*, under *c*, and *c* is drawn down by the shuttle cord to the gauge where the knot at *b* is made. To begin the second and alternate knots the shuttle would of course pass under *a a* and over *c*. Cord for the continuance of the loops is drawn from the ball by loosening the windings around *a a*. When the knot (called ka, umii, etc.) slips properly into place, as at *b* and *d*, the worker ejaculates *kakiokohe* with satisfaction, but if it misses the loop, as at *c*, the word *omauokole* is uttered with disgusted tone. Sometimes, as the work proceeds, two loops are by mistake enclosed by one knot, the name for which is *mauae*.

In this division come the *nae*, or netting which constitutes the groundwork of feather garments,[48] netted *malo*, bird net and the regular fish netting.

Nae.—Nae is a netting of very fine mesh, varying in the Museum feather garments from .05 to .27 inches. The twine is not as fine as the size of the mesh might suggest, averaging .025 inch in diameter, so that in some of the specimens the

[48] B. P. B. Museum; Memoirs, vol. i, nos. 1 and 5.

netting is as close as loose burlap.[49] As stated by Dr. Brigham, in Feather Work, the bases of the cloaks are composed of several pieces of nae, each being cut to fit. The pieces are not always of the same mesh, that of those in the cloak of Kiwalao, for instance, varying from .1 to .25 inch. However, the mesh of the majority varies but slightly in each individual.

The closeness of the mesh in some cloaks and capes has suggested research for a suitable shuttle to do the work, but beyond the niao, already described, and needle of kauila wood, no implement has been found. In a piece of nae, specimen No. 2840[50], prepared for the addition of feathers, the mesh increases from .05 at the top to .08 inch at the bottom and is too fine to allow even an ordinary pinhead to pass through readily. The specimen is 37.5 inches wide and 11.5 inches long, the edges of which have been trimmed at the knot without leaving the usual netting selvage. There are from four to ten rows of netting continuously in both directions, while of course in netting the rows usually alternate. This nae was made without a shuttle with lengths of twine drawn through the loops, and for such purposes the natives dipped the ends of the twine into the highly saccharine juice of the *ki* root, which, drying rapidly, made the fibre stiff enough to be threaded through the holes. It is not the intention of the writer to give the impression that all nae have a number of rows of netting continuously running in the same direction, for in most of the specimens the rows alternate regularly. The nae with a mesh of .25 inch could be and probably was made with a shuttle such as that shown in the middle of Fig. 101, or a niao.

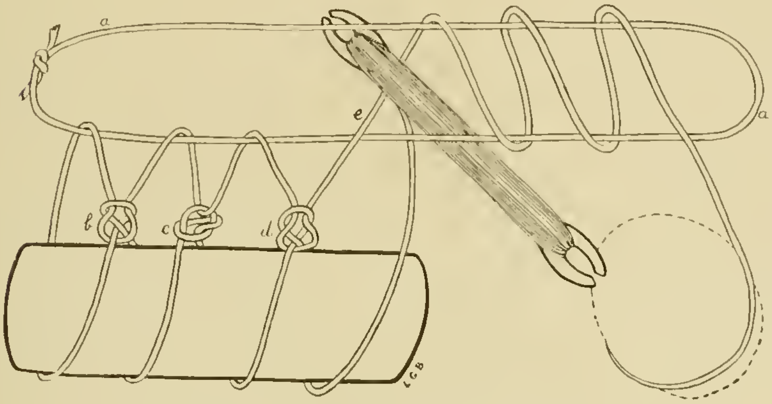


FIG. 163. COMMENCEMENT OF A NET.

In the collection is a piece of unfinished netting of rather fine mesh, the history of which is unknown. The upper part is 41 inches wide with a mesh of .25 inch increasing to .44 inch in the lower, and it has, as far as completed, the shape of a feather cloak. The first half has been made with four shuttles, one following the other, and possibly by four people, and the unfinished half with three shuttles as the three loose strings on the bottom indicate. The specimen is Hawaiian and is probably the result of an incompleted later day attempt to prepare nae for a feather cloak. Sometimes in making very broad fish nets, or when there was need for rapid manufacture, two or three men would net along the same side, following each other. The cord, of the first man to finish, was knotted to the ends of the succeeding rows when completed and was the first to begin the next series.

---

[49] Ibid, pl. ix, upper figure, left side.

[50] Ibid.

Netted Malo.—Of netted malo there are two specimens in the Museum, each with a mesh of about .25 inch. One, No. 2842, is a plain piece of netting 15.3 ft. long and 7 in. wide.[51] The malo, or loin cloth, of oloná netting was always an alii's garment and was worn by him on canoe voyages.

The other specimen,[52] No. 6921, 12.2 ft. long and 5.7 in. wide, came to the Museum from the Provisional Government of Hawaii after the revolution in 1893, as a relic of royalty, with the royal feather robes. It has been the nae of a feather malo, and in sewing on the tufts of feathers, the meshes have been so compressed as to give the fabric the semblance of cloth. The stitches are in good order still, but few shafts and no feathers remain. There are not left enough fragments of feathers to even show the general color, but red, yellow and black stumps were found, all on the front end. Near this end are the remains of black feathers on the outline of a diamond, and a little nearer the middle, thread bindings indicating the former presence of a feather cross shaped like St. Andrew's. To the ends of the malo are attached rows of human molars, and to the sides near the cross a single molar. Looped to the sides, every two inches for the entire length, is a cord enclosed in a fine cylindrical netting, by which feathers have been fastened in the form of a lei.

Upena Manu.—The Museum possesses but one specimen of bird net,[53] No. 138. This is a diamond-shaped net, mesh 5 inches, made with the same sized twine as in nae. Its total length when stretched is 16.25 feet, and in width it increases from 18 meshes at the beginning to 40 meshes at the middle, thence diminishing to 13 meshes at the end. At each end the meshes are bound together. The increase of the number of meshes in a row is accomplished by running on an additional loop (as at *g*, Fig. 111) at regular intervals, while the decrease is effected by the use of the manae knot, called *makakukai*. A cord of about .1 inch in thickness is run along both sides, but there are no sticks attached, nor any place for attachment. The net has been tanned and, where broken, mended with tanned and untanned twine. The method of use is unknown, but judging from the large mesh and fine twine it was used for entangling. Natives have told the writer of two methods of bird-catching with nets, one of which was to lie concealed on the hills in wait for the birds returning from the sea at nightfall, and as they approached heavy with food and flying low, to suddenly appear and raise the net: the startled bird darted upward and became enmeshed. The other method was used for plover when resting on rocks inside the coral reef. The hunter chose a dark night and waded at high tide to one of the uncovered rocks. The net was wetted and silently shaken over the sleeping birds, which, waking and expecting rain, crowded closer together and slept again. The shower was repeated several times and the hunter, then sure of his quarry, threw the net over the group and held down the edges close to the rock with his hands and feet. When the birds were exhausted with their struggling, the net was gathered together with the booty inside.

---

[51] Ibid, pl. ix, middle of upper figure.

[52] Two old Hawaiian ladies who had been continually at court during the reigns of several monarchs were shown this malo, and both independently affirmed that it was the malo of Liloa. The story of Liloa and his son Umi has been told too many times to repeat here. Liloa reigned on Hawaii at the latter part of the fifteenth century. It is possible that oloná fibre may outlast the intervening period, and, as the malo constituted the most important part of Umi's family credentials, the succeeding ruling chiefs would have preserved it with reverential care. There are several faint stains on the netting, but whether blood stains or not it is impossible to tell.

[53] B. P. B. Museum Memoirs, vol. i, no. 1, p. 13.

Fish Nets.—Upena, or fish nets and methods of using them have been described with considerable detail in Mrs. Beckley's[54] concise and complete article on Hawaiian fisheries, and Mr. Cobb's[55] comprehensive work on the commercial fisheries of these islands, in which is incorporated that of Mrs. Beckley. It will therefore not be necessary to do more than mention the nets of only Hawaiian origin, and describe and list such as are in the Museum.

The netting tools and the sizes of the mesh have been mentioned above. The material used was oloná, with rare exceptions. There is an upena ahuulu in the collection, No. 764, with unusually thick closely spun cord, which on examination proved to be waoke. In this example—a small hand net—it is probable that some cord prepared for koko was substituted during a scarcity of oloná. The other materials were hau, coir and ahuawa. For the shark net, upena mano, hau bark was stripped from the tree and while fresh was roughly twisted into thick rope. Hau and ahuawa were used for the rough turtle net—upena honu. Coir netting is said to have been used to lie in the water, as a protecttion against sharks, a few feet outside an oloná net in which captured fish were awaiting landing. Fishermen declare that sharks dislike the roughness of an article manufactured of coir. Another fisherman stated that the Hawaiian nets were not of coir, and that the use of such material was due to the Gilbert Islanders, of whom there was a large colony here for a generation up to a few years ago. Taking into consideration the abundance of oloná in this place and its flexibility, and the small size and scarcity of coconuts in these islands, it would seem natural that of the two the natives would turn to oloná as the staple. A number of the Museum nets have been tanned, the process merely requiring the steeping of the net and fresh bark of the *kukui* (*Aleurites triloba*) in water for several days.

---

[54] Emma Metcalf Beckley. Hawaiian Fisheries and Methods of Fishing. Honolulu, 1883.

[55] John N. Cobb. Commercial Fisheries of the Hawaiian Islands, U. S. Fish Commission Report for 1901. Washington, 1902. It might be mentioned that in Mr. Cobb's excellent report are a number of sketches of fishing implements in this Museum, the acknowledgment of which has undoubtedly been overlooked by that gentleman.

Fish nets are frequently composed of two or more pieces of netting run together with a cord. Five methods of making this joining were noticed, the simplest being with a cord, called *aea*, drawn through the meshes of the two edges in turn. The second was by placing the meshes of the two edges exactly opposite and with a single cord tying them together in order, using a single knot. The third was to lay the edges together with the meshes alternating and then running the cord from one side to the other with a single knot at every mesh; this at first glance has the appearance of continuous netting. The fourth method of joining was to net on one edge and run the shuttle in turn through the loops of the other edge. The fifth was by joining the two edges by the usual form of netting. A number of the smaller nets, particularly those of small meshes seem to have been cut down or made of pieces taken from larger nets; in such cases the netted knot forming the edge seems to have stood the usual wear and tear. When a net has been torn or broken, more generally with the fine meshed nets, the mending was sometimes effected with an aea, or a piece was cut from an old net, laid over the hole and sewed on by the same method. Large nets are sometimes fastened together by a rope called *kukai*.

The name alihi was applied to the head and foot ropes, the full names being respectively alihi *pikoi* and alihi *pohaku*, or more recently alihi *kepau*. The pikoi was a float of wood, hau preferably, but failing that, kukui. Wiliwili (*Erythrina monosperma*), the lightest wood in the islands, was not considered sufficiently durable. In recent times two other woods have become available for the pikoi, and since their introduction oleander (*Nerium oleander*) and the castor oil tree (*Ricinus communis*) have been added to the list. The shape of the pikoi varied. In some, a large branch was cut into sections and the pieces split, and from these the pikoi was made (a block about 4 inches long, 3 inches wide and 1 inch thick). It was fastened through holes drilled in its side to the alihi. Another form was a section of a branch about 4 inches long, and 2.7 inches in diameter, which was pierced on the side and so attached. The heart wood in the kinds used was soft, and could be easily removed to allow the pikoi strung on the alihi, but it is uncertain if this kind of pikoi was of ancient use. Sinkers of pohaku (stone) and kepau (lead) were shaped to suit. Sticks used to support or distend a net were called *kuku*, and when curved or bent were also called *kaka*. To make the necessary length for the kuku or kaka two or more sticks were fastened together by overlapping and binding the ends. In referring to the nets by their native names, it should be mentioned that one form of fish net is occasionally used for various kinds of fishing and has a different name in each, and that the same name is sometimes applied to different nets in various parts of the islands.

UPENA PAPAI, CRAB NET.—One specimen, No. 762. This is a flat, circular sieve from 20 to 23 inches in diameter. The frame is composed of two kaka securely fastened. Stretched across the hoop is a set of parallel heavy cords one inch apart, at right angles to which is a second set the same distance apart and merely knotted to the first. This sieve of course cannot be called netting. Such an implement was mainly useful in throwing the crabs ashore after they had been enticed within range by a piece of bait. Fishermen report another style of upena papai, illustrated by Mr. Cobb,[56] in which the cords of the sieve give place to a conical net.

UPENA PAOO, OR UPENA IAO.—One specimen, No. 761. A small, fine-meshed, tanned dip net suspended from an ovate-acuminate frame, which shape is called *poo*. The frame is rigid and is composed of kaka bent until the ends meet at the point, where they are bound together and form the handle. A cross piece is tied to the frame seven inches from the handle. The net tapers irregularly to a point, which is directly below the handle. The mesh varies somewhat; adjoining the frame is a band of netting 4.5 inches wide of .75 inch mesh joined at the handle. Then come several rectangular pieces of nae averaging .2 inches in mesh. All the connections are with aea. These pieces have no selvage, and have probably been cut from the remains of a larger net. Length and breadth of frame, 32 and 17 inches. Depth of net 23 inches.

UPENA KAEE, OR KAEE PAOO.—One specimen, No. 765. The name is practically the same as that previously mentioned. The specimen is a small fine-meshed untanned scoop net with a frame similar to but longer and narrower than No. 761 and without cross piece. The kaka are two long pliant wands, resembling willow, twisted together. The frame is so pliant that it may be readily elongated by a little pressure at the handle and the opening thereby reduced in size. The net is shaped like a very broad sack, and is gathered very much at the upper margin. In this specimen the netting has been done for the purpose. The mesh of the top row is 1 inch, and has been reduced from .4 inch in the second row to .2 inch at the bottom. As netted, it was long and narrow, and to reach its present form, was doubled and netted together at the bottom and one side. Length and breadth of frame 27 and 9 inches. Length of net at bottom, 47 inches, depth 10 inches.

UPENA AHUULU, OR UPENA PUNI.—Two specimens, Nos. 763 and 764. In this style of net the kaka are two parallel sticks about 3.5 feet long. The net, of medium sized mesh, is a single piece of netting folded together and sewed at the bottom and side by the second or third method mentioned above. The top edges of the bag thus formed are attached one to each of the kaka for about three-fourths the length, the balance of the kaka remaining bare for handles. Where the two sides of the bag meet the kaka, the latter are fastened and prevented from spreading by cords about two inches long. The kaka are of about equal strength, and by holding the points of the handles in the palm of the hand and springing the sticks apart with the fingers, the kaka, being tied at the other end, become bowed and so open the mouth of the net wider when necessary. No. 763 is of oloná, and No. 764 of waoke, both tanned. The measurements are:—

---

[56] Ibid, pl. 23.

763. Length of kaka 42 in., width apart 2–2.3 in.; length of net 33 in. or 25 meshes, depth 16 meshes, mesh 1.4 in.
764. Length of kaka 44 in., width apart 2.–2.5 in.; length of net 36 in. or 16 1-2 meshes, depth 8 1-2 meshes, mesh 2 in.

UPENA HOLOHOLO, OR UPENA POO.—One specimen, No. 5176. A large tanned dip net with a frame the same shape as No. 761, but three times as long and twice as broad. The cross piece is 16 inches from the point. The net has a mesh of 2 inches, and is composed of a piece of netting folded together and netted along the sides to form a bag. The net is suspended from the frame as far as the cross piece, the balance of the kaka being left uncovered for the handle. Length of frame 8.3 feet, width 2.8 feet. Length of net, 81 meshes, depth 24 meshes.

UPENA UHU.—Four specimens, Nos. 766, 767, 768 and 5175. These specimens are each composed of a square piece of netting stretched flat by alihi, which are fastened by the corners to the ends of two kaka tied at right angles to each other at the middle. The diagonal of the netting is less than the length of the kaka, so that the latter are somewhat arched when in position. Weights of stone, or lead, are fastened to the ends of each kaka. Specimen No. 766 is labelled *upena akiikii*, and has a mesh considerably smaller than the other nets of this kind. *Upena pakiikii* is probably the same.

766. Upena akiikii, length of kaka 6.5 ft., size of net 21×22 1-2 meshes, mesh 2.3 in.
767. Upena uhu, length of kaka 8.3 ft., size of net 10 1-2×18 meshes, mesh 6 in.
768. Upena uhu, length of kaka 8.5 ft., size of net 16×17 1-2 meshes, mesh 5.3 in.
5175. Upena uhu, without kaka, size of net 15×15 meshes, mesh 4.5 in.

Mr. Cobb's description[57] of an upena uhu does not seem to agree with the specimens in the Museum, nor with the evidence of fishermen consulted. The piece of netting is hardly bagged at all, and is almost as flat as a piece of netting can be in horizontal suspension. The kaka, which Mr. Cobb states were made "to swing around and lie parallel" and thereby close the mouth of the net to retain the fish, are fixtures when the implement is set up and cannot be moved from their relative position without drawing the net to the surface where the hand can reach and untie them. In drawing the implement rapidly through the water the net would of course act as a drag and bow the kaka somewhat, and bag the net, but the sticks are too stiff to bend much. The secret in catching the uhu, as described to the writer, is the knowledge that the instinct of the fish when disturbed is to dart to the bottom, and the uhu after being enticed into the net by the decoy spends its time in trying to swim through the meshes underneath. But one fish is caught with each dipping of this net.

---

[57] Ibid.

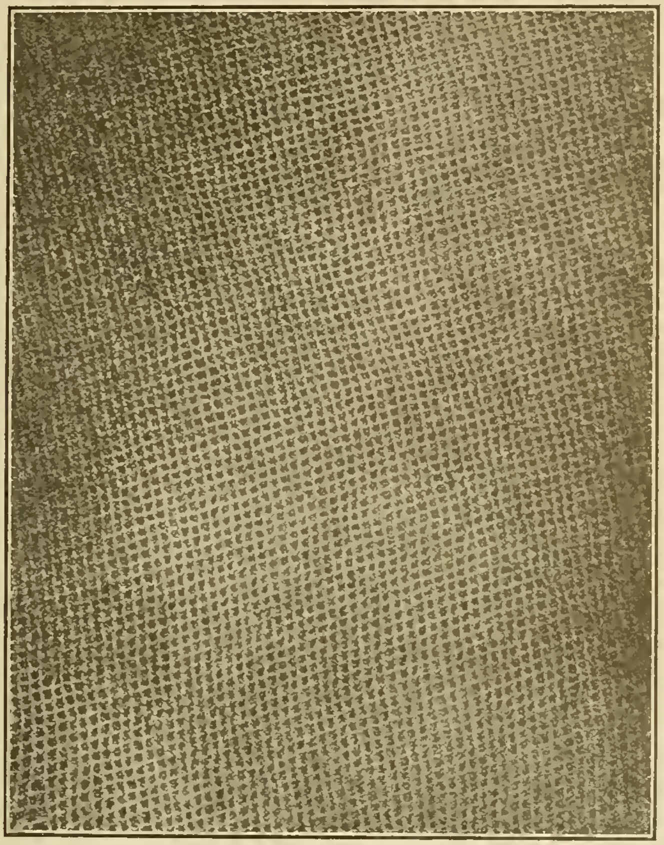


FIG. 164. SAMPLE OF .4 INCH MESH.

The scoop net described by Mr. Cobb on page 407[58] is known to the natives as *kaee*. There is a scoop net in the collections, No. 9052, without name or history, which from its appearance might well be used as a kaee also. It has a frame composed of two kuku 3.7 feet long, forked at one end; at the forked end they lie 2.3 feet apart, and come together at the others for the handle. Near the handle is a cross piece 8 inches long. Resting in the two forks is a kaka 6 feet long made by joining two slight wands. The net, .8 inch mesh, was a piece 51 meshes deep and 153 wide, and this has been sewed at the bottom and side by aea, making a bag 76 meshes wide. The top edge of the bag is fastened to the kaka which is somewhat bowed by the tension. About the middle of the two kuku, the sides of the bag are tied to the sticks and from the bottom of the bag is a cord reaching to the end of the handles. This net in position lies on the kuku with a wide mouth on the ground held wide open by the kaka which is bent around in a semicircle. Behind the mouth and sloping up towards the hand is the bag.

UPENA NAE KUKU.—Three specimens, Nos. 756, 757 and 6578, untanned. This is a scoop or bag net, of very fine mesh as indicated by the name. It is shaped like a sack, broader than long, with the end and top open, and gathered at the upper edges. Along part of these edges, Fig. 165, two kuku are tied, with their ends resting in rings at the corners. In operation these ends are placed on the sea bottom as far apart as the mouth of the net will allow and the sticks elevated at an angle of about 45°. The closed end of the bag drops behind like a pocket. These nets are composed of several pieces joined by aea and growing finer in mesh towards the pocket. In the figure is given a plan of No. 6578 showing the meshes and sizes of the various pieces. This specimen is called upena nae hinana, or upena hinana and is of particularly fine mesh. Fig. 164 shows a sample of .4 inch mesh in No. 757. The twine in these nets is much heavier than might be expected in those of such close mesh.

---

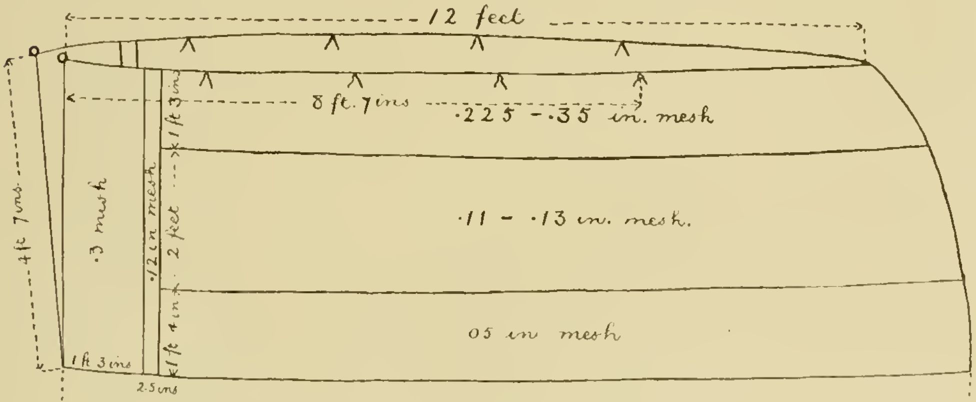
[58] Ibid.

756. Total length 7.5 ft., depth 4 ft., mesh .25–.4 in., length of kuku 4 ft.
757. Total length 25 ft., depth 7 ft., mesh .3–.5 in., length of kuku 17.5 ft.
6578. Total length 13.3 ft., depth 4.6 ft., mesh .05–.35 in., length of kuku 8.6 ft.

It is probable that the nets described as *upena nehu*, *upena pua*, *kapuni nehu* and *upena iiao* by Mrs. Beckley and Mr. Cobb would all come under the above description.

UPENA KAILI, OR UPENA AAI-OPELU.—One specimen, No. 760. This is a large semiglobular bag net suspended from two kaka. In position the ends of the kaka are overlapped and tied, making a circular opening. The length of the kaka is the same as that of the fishing canoe. Three men handle the net, one to draw the net to the surface, and one at each end of the canoe to untie the ends of the kaka and allow the sticks to spring to. The bottom of the net opens into a small bag, to which is fastened the stone sinker. In the specimen the kaka are wanting. This specimen was made of many pieces of netting of various meshes. On the top is a narrow band 7 meshes wide of 2.5 inch mesh. Then follows a band of 35 meshes wide and 2 inch mesh. The rest of the netting is 1.2 inches mesh, and, with the exception of the bag at the bottom, was made in two vertical sections. Each section was made up of strips of netting drooping at the middle, gathered at the upper edge and joined at the ends to the netting of 2 inch mesh. By this means the native secured the oval shape. Where portions of the ends overlapped, the larger sized net was cut and the piece fitted. The strips and sections were run together by aea. To attach the bag, the two bottom strips were cut in the middle of the lower edge and the bag fastened by the same cord as before. The bag was a broad piece of netting, netted at the sides, with an open bottom which was closed when fishing by tying with cord. It might be mentioned that the bag is 105 meshes round, while the opening in the bottom of the larger net is only 76 meshes in circumference. This specimen is 48 feet in circumference at the top; the depth, hanging flat, is 19.5 feet and that of the bag 2.9 feet. *Upena kaihi* is said to be similar to this net.

UPENA EKE.—One specimen, No. 5310. This specimen is an old untanned bag net, of which most of the bottom is missing. When in operation it is a long horizontal bag, tapering but slightly away from the mouth, which is at one end. At the other end in the specimen is an opening less than half the size of the mouth, where probably was fastened a closed bag of smaller size. In section, the bag is semicircular, with the arc above. The bottom part of the net called *honua* is anchored by stones at the corners of the mouth and at two points along each side about ten and twenty feet from the mouth. Between these points, stretching the honua wide are sticks called *puhi*. There is another stone at the tail end of the bag. To the upper curved part, called *lana*, the pikoi are fastened in great numbers in irregular rows. Heavy ropes of hau run the whole length of the bag, one along each edge and one on each slope of the lana about 8 feet from the edge. The total length of the lana is 39 feet, the first 21 feet from the mouth being light cord of .08 inch in thickness and of 1.5 inches mesh, and the rest of heavy cord .17 inch thick and 1.2–1.4 inches mesh. The lana is 29 feet in width at the mouth, measuring the ropes, and the lighter portion is made up of five pieces of wide netting averaging 33 meshes long and decreasing from 407 meshes wide in the first piece at the mouth to 238 meshes in the fifth. The pieces are run together by aea, in this net called *iwi puhi*. This method of tapering a net seems to have been preferred by natives to the use of the knot known as makakukai, already mentioned. The heavier part of the lana is in two pieces, 112 and 70 meshes long, and respectively 170 and 165 meshes wide. Of the honua, there remains but one piece, of the heavier cord, at the rear end. It is about 11 feet or 113 meshes long and 130 meshes wide. Leading away from the sides of the mouth, there should be two long nets called *paku*, the same depth as the bag, at a wide angle to each other, as a drive. The net on the right is said to be 15 fathoms long, and that on the left 10 fathoms. *Upena kolo* is said to be a net on the same lines as the preceding, but on a much larger scale. The same is reported of the net used in *Lau kapalili*. It is probable that the nets called *papahului* and *au-mai-ewa* and used in conjunction with each other are also similar.



NO. 165. DIAGRAM OF UPENA NAE KUKU.

Hano Ohua, or Upena Ohua.—One specimen, No. 7072. This specimen has been made of pieces of netting purchased from and netted by Chinese from Chinese fibre, and run together by natives by aea in what is probably one of their ancient forms of fish nets. The knot is what is known as the square or reef knot and is a poor one for fish nets. The mouth is semicircular, 11.8 feet at the base and 19.5 feet along the arc, and from there tapers to a small hole 2 inches in diameter. The length of the upper side is 11.8 feet, and of the lower 9 feet. The mesh is about .5 inch. The mouth is leaded at the bottom, and along the upper part is closely strung a row of pikoi. Fig. 166. *Hano iao* and *hano malolo* are reported as having this shape, the latter being a much larger net.

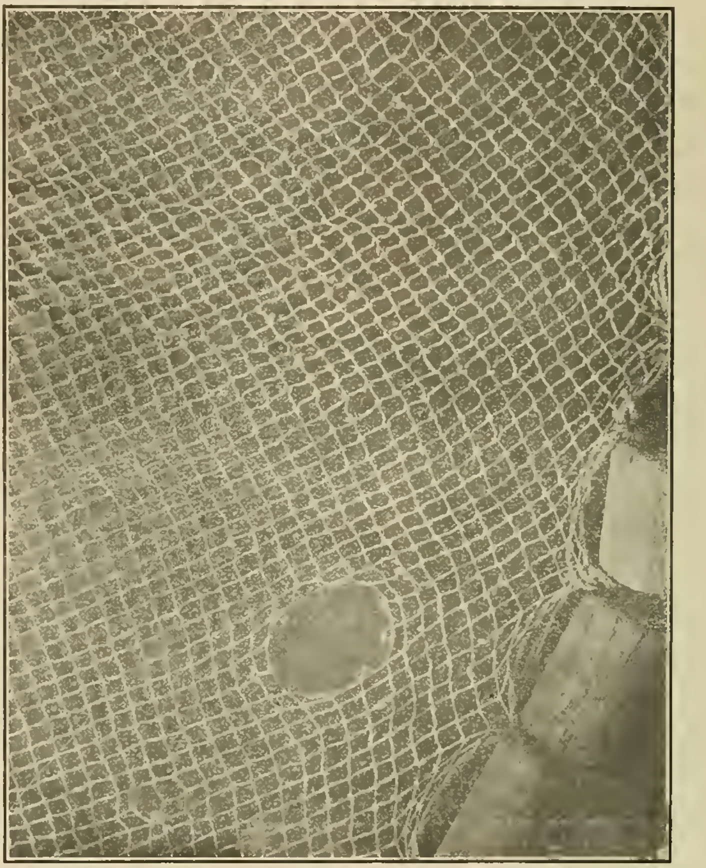


FIG. 166. HANO OHUA.

Upena Kuu, Upena Paloa, or, generally speaking, seines or gill nets. Two specimens, Nos. 758 and 759, tanned.

758. Length 82 ft., depth 7 ft. or 41 meshes, mesh 2.2 in.
759. Length 66 ft., depth 10.5 or 48 meshes, mesh 3.3 in.

The names of some of the nets reported[59] under this heading are *akuikui* or *pakuikui*, *uluulu*, *kawaa*, *kupo*, *luelue*, *pahu*, *papaolewalewa*, *pouono*. Occasionally a kuku was fastened to each end of the net, and was of great assistance when drawing the net through the water.

Upena Mano and Upena Honu.—Large meshed roughly made nets of about 12 or 6 in. mesh respectively. They are reported to be about 100 ft. long and 6 ft. deep.

There are several other names,[60] attributed to fish nets, for which the writer has been unable to find descriptions, viz.: *apai*, *uhina*, *kai*, *kaii*, *kuleohua*, *lualua*, *makui*. Some of these names no doubt refer to forms of the nets described above.

In concluding, the writer wishes to express his appreciation and thanks to Mr. L. G. Blackman for his careful and painstaking drawings, and to Dr. W. T. Brigham, Professor Otis T. Mason and many others for suggestions and information cheerfully given and the generous loan of specimens.

---

[59] Hawaiian Antiquities, by David Malo, pp. 277, 279, 280, and Andrews' Hawaiian Dictionary. [60] Ibid.

Publications of the Bernice Pauahi Bishop Museum.

A Handbook for the Bishop Museum. Oblong octavo, 94 half-tone illustrations. Price 50 cents; postage 9 cents.

Occasional Papers, Vol. I. Octavo.

No. 1. Director's Report, 1898. Visits to Ethnological museums in a journey around the world. Price 50 cents; postage 5 cents.

No. 2. Director's Annual Report, 1899. Mat Sails of the Pacific (Stokes). Ray-skin Rasps (Walcott). Notes on the Birds of Oahu (Seale). Price 50 cents; postage 4 cents.

No. 3. Director's Annual Report, 1900. Visit to the American museums (Stokes). Mission to Guam (Seale). Notes on the Birds of Kauai (Bryan and Seale). Price $1; postage 8 cents.

No. 4. New Hawaiian Fishes. By Alvin Seale. Price 25 cents; postage 2 cents.

No. 5. Director's Annual Report, 1901, and Index to Vol. I. Illustrations of sperm whale and bird groups. Price 50 cents; postage 4 cents.

Occasional Papers, Vol. II.

No. 1. Director's Annual Report, 1902. Noteworthy Hawaiian Stone Implements (Brigham). Fibres of the Hawaiian Islands (Blackman). Distribution and Variation of Achatinella multizonata (Cooke). Monograph of Marcus Island (Bryan). Price $1; postage 7 cents.

No. 2. Director's Annual Report, 1903. Remarks on Phallic Stones from Rapanui (J. L. Young). Aboriginal Wooden Weapons of Australia (Blackman). Price 40 cents; postage 4 cents.

No. 3. Director's Annual Report, 1904. Australian Bark Canoe (Brigham). A Stone Dagger for Duelling (Brigham). Notes on the Birds of the Waianae Mountains (Bryan). Additional Notes on the Nesting Habits of the Hawaiian Owl (Bryan). Description of the Nest and Eggs of Chlorodrepanis virens (Gmel.) (Bryan). Notes on the American Birds Collected in the Hawaiian Islands by Mr. Gerrit Wilder (Bryan). A Bird's Nest of Pele's Hair (Bryan). Two Undescribed Nests and an Egg of a Hawaiian Bird (Bryan). Price 50 cents; postage 5 cents.

No. 4. Director's Annual Report, 1905. Old Hawaiian Carvings (Brigham). Three New Hawaiian Fishes (Bryan.) Report of a Visit to Midway Island (Bryan). Nest of Hawaiian Hawk (Bryan). In press.

Occasional Papers, Vol. III. Reprints of Original Descriptions of Achatinellae. By E. W. Thwing. In press.

Occasional Papers, Vol. IV. Fishes of the South Seas. By Alvin Seale. In press.

Memoirs, Vol. I. Quarto.

No. 1. Hawaiian Feather Work. By Wm. T. Brigham. Price $ .50; postage 14 cents.

No. 2. Index to the Islands of the Pacific. By Wm. T. Brigham. Price $1.50; postage 20 cents.

No. 3. Key to the Birds of the Hawaiian Group. By Wm. Alanson Bryan. Price $1.50; postage 13 cents.

No. 4. Ancient Hawaiian Stone Implements. By Wm. T. Brigham. Price $2.50; postage 20 cents.

No. 5. Supplement to Hawaiian Feather Work, with Index to Vol. I. By Wm. T. Brigham. Price 75 cents; postage 8 cents.

Memoirs, Vol. II.

No. 1. Hawaiian Mat and Basket Weaving (Brigham). Hawaiian Nets and Nettings (Stokes). Price $3; postage 20 cents.

MAY 30 1906
14,372

MEMOIRS

OF

THE BERNICE PAUAHI BISHOP MUSEUM

OF

POLYNESIAN ETHNOLOGY

AND

NATURAL HISTORY.

Vol. II — No. 2.

Old Hawaiian Carvings.

HONOLULU, H. I.:
Bishop Museum Press.
1906.

BOARD OF TRUSTEES

Sanford B. Dole, LL.D.	President
Henry Holmes	Vice-President
Alfred W. Carter	Secretary
Joseph O. Carter	Treasurer

Samuel M. Damon William O. Smith E. Faxon Bishop

MUSEUM STAFF

William T. Brigham, Sc.D. (Columbia)	Director
William H. Dall	Honorary Curator of Mollusca
William A. Bryan	Curator of Ornithology
John F. G. Stokes	Curator of Polynesian Ethnology
Leopold G. Blackman	Assistant, and Acting Librarian
C. Montague Cooke, Jr., Ph.D. (Yale)	Assistant
John J. Greene	Printer

MAY [illegible]

OLD HAWAIIAN CARVINGS

FOUND IN A CAVE ON THE ISLAND OF HAWAII

FIGURED AND DESCRIBED
BY
WILLIAM T. BRIGHAM

Memoirs of the Bernice Pauahi
Bishop Museum

Vol. II—No. 2

HONOLULU
Bishop Museum Press
1906

ILLUSTRATIONS IN THE TEXT.

FROM PHOTOGRAPHS BY THE AUTHOR.

Two Aumakua placed to guard the cave deposit .... Title page
Plan and section of the Cave, sketched by David Forbes 4
First portrait Statuette 5
Second portrait Statuette 6
Profiles of Statuettes 7
Side view of Aumakua 8
Back view of Aumakua 9
Bowl carved with female figures and inlaid with human teeth 10
Top of carved Bowl 11
End of carved Bowl showing face of one figure 11
Other end of carved Bowl showing face of other figure 11
Ipu aina or Slop Bowl inlaid with human teeth and bone 12
Similar Ipu aina in the Bishop Museum 13
Papamu for playing the game of Konane 14
Carved Bowl in the British Museum from Hawaii, showing similar supports 14
Carving tool of shark tooth mounted in the end of a human clavicle 15
Shark tooth carving tool in British Museum 15
Hue wai curiously moulded in growth by net work 17
Bare net work of feather cape once covered with red feathers 18
Funnel-shaped carving of wood, use unknown 19
Painted Fan 19
Fragment of a porcelain dish (Chinese) 20

PLATE.

Enlargement of the carved portion of two Aumakuas .... Plate XVII

Old Hawaiian Carvings found in 1905 secreted in a cave on Hawaii. Figured and described by WILLIAM T. BRIGHAM, Sc.D. (Columbia), *Director of the Bishop Museum.*

IN a cave on the western portion of Hawaii, of which the main opening was not concealed, a number of human remains were deposited, some of great antiquity, others certainly after the advent of the white men. So far there was nothing to distinguish this from scores of other burial caves, some abandoned, others still in use in the rural districts: all are bubbles or channels in ancient lava streams,—streams which have gradually built up the islands and are still occasionally poured forth from the active volcanoes of Hawaii. In recent years streams have flowed the same way as the ancient lava torrents which were used as burial caves, and the Bishop Museum contains articles snatched from these caves before the advancing flow.

To one familiar with these caves the vestibule, as it may be called, is the least interesting portion; it is a tunnel of varying size and irregular section, often shrinking to a passage hardly large enough to admit a man's body, then expanding into a hall of considerable height, and with numerous ramifications, some small as rat holes, others of a size to admit a horse. In the old and important caves these side passages are generally walled up, and originally this was done so effectually as to conceal the entrance, but earthquakes and time have loosened the dry stone wall, and it is now possible to detect it, unless the deposited and decaying bones cover it, and these one hesitates to disturb unnecessarily. Behind these walls lie the interests of the cave. One may pull down with great labor in the dark and ill ventilated cave the carefully placed wall and find in the chamber behind it perhaps nothing, perhaps a few crumbling bones or a decayed calabash.

Of three explorers of the cave around which centres the interest of this account, one had often explored such caves in search of water, and coming from a side chamber where was a corpse in a canoe raised on a stand with choice mats and kapa, he noticed a wall not far from the entrance to this burial chamber (Fig. 1). After much hard work a small opening was made and the recess entered. There were fragmentary human remains, but on one side of the chamber were the articles which are the subject of this paper wrapped carefully in kapa. What connection they have, if any, with the bones in the main cave, or those in the branch chamber I cannot say: perhaps they were simply hidden here as the safest place of deposit known,—in the guardianship of the

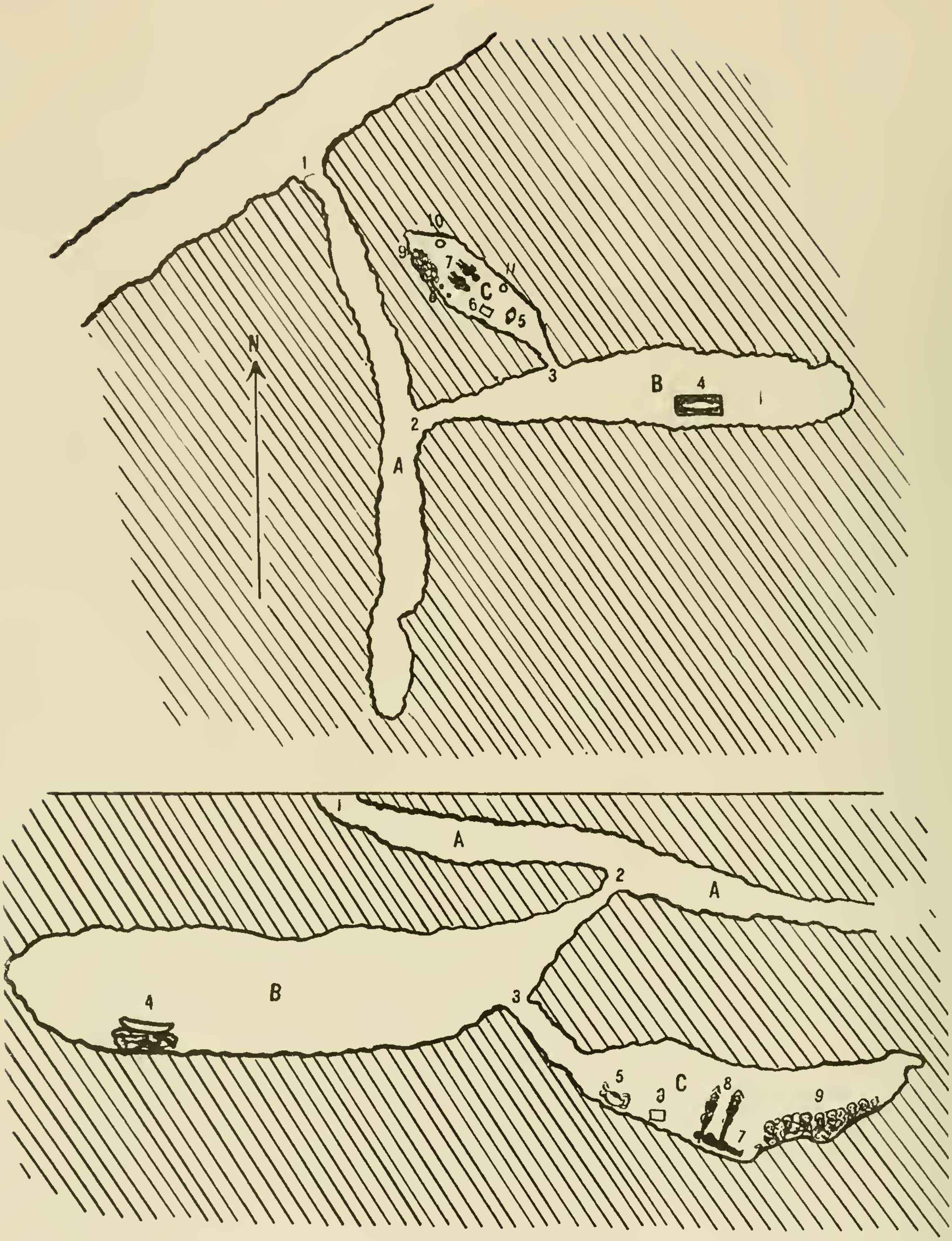


FIG. 1. SKETCH PLAN OF PART OF THE CAVE.

1. Opening to cave from gulch.
2. Branch opening to B, closed with rocks.
3. Branch opening to C, closed with rocks.
4. Canoe with skeleton, feet to east.
5. Wooden bowl with carved figure.
6. Papamu or konane board.
7. Two human figures, heads to east.
8. Two aumakuas leaning against wall.
9. Skulls and bones rolled in kapa.
10. Ipu aina with human teeth.
11. Large gourd containing skeleton of infant.

dead. It has been suggested that they form the paraphernalia of a temple and were hidden, as so many of the idols were, at the time of the general destruction of the idols in 1819 in the hope that the storm would blow over and better times ensue, but there is absolutely nothing in the collection to support such a view. The two gods or *aumakua* were household deities, the other articles might be the private property of some chief or priest, and two things,—the fan and bit of porcelain are such keepsakes as were commonly deposited with the dead to whom the articles had belonged.

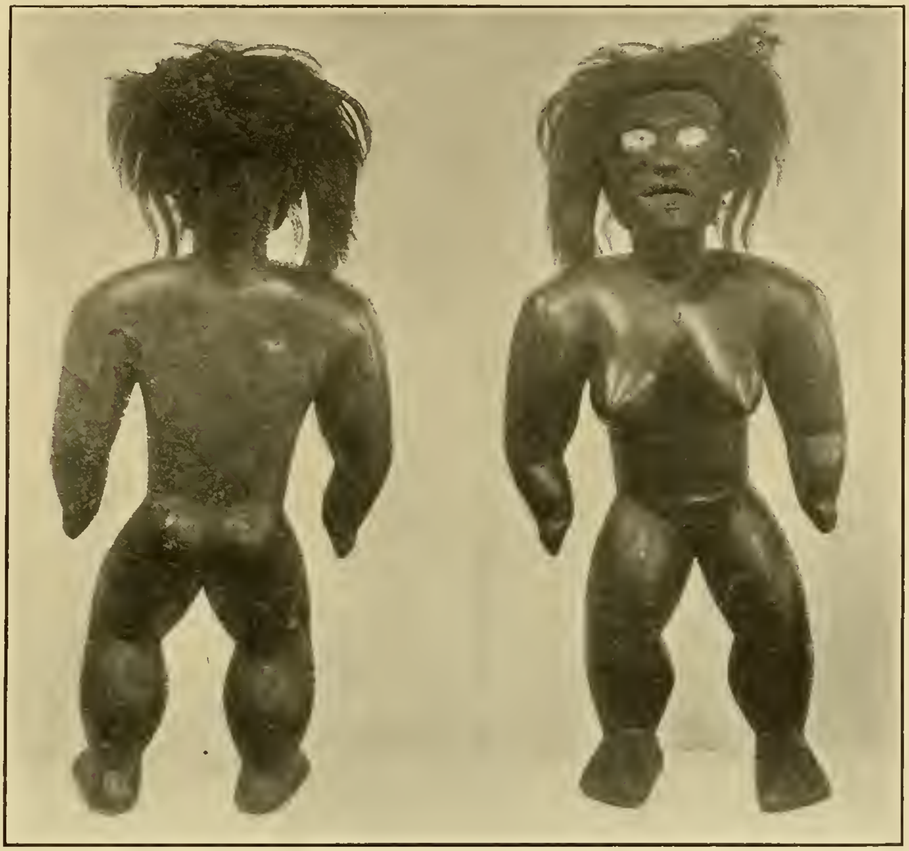


FIG. 2. FEMALE PORTRAIT STATUETTE.

The objects were carefully wrapped in kapa, but the explorers unfortunately removed all this without especially noting the kinds used on each, and we are deprived of any clew this disposition might afford. We have the letter but the addressed

---

The cave opening was about 30 feet above the bottom of a dry gulch running northeast and southwest. It was about 3 feet wide and the passage into which it led (A) was about 55 feet long. At about half the height a walled-up opening (2) was found leading to a narrow passage, 2 feet wide, soon opening into a chamber (B) approximately 10 feet high and wide with a length of 30 feet. This chamber (B) contained a human skeleton placed in a canoe and raised on a stand (4). As will be seen in the lower diagram this chamber is below the passage A. Another walled-up door (3) led to a passage about 2 feet wide and 7 feet long opening into a chamber (C) perhaps 20 feet long and 7 feet wide and high. In this last chamber were the articles here described.

envelope was torn off. In passing it should be mentioned that the kapa was in fair preservation, some of the specimens being of very choice quality, such as was generally made only by women of high position.

First and most important in the find are two wooden statuettes, both female, perhaps mother and daughter, which I consider portraits,[1] and if this conjecture be

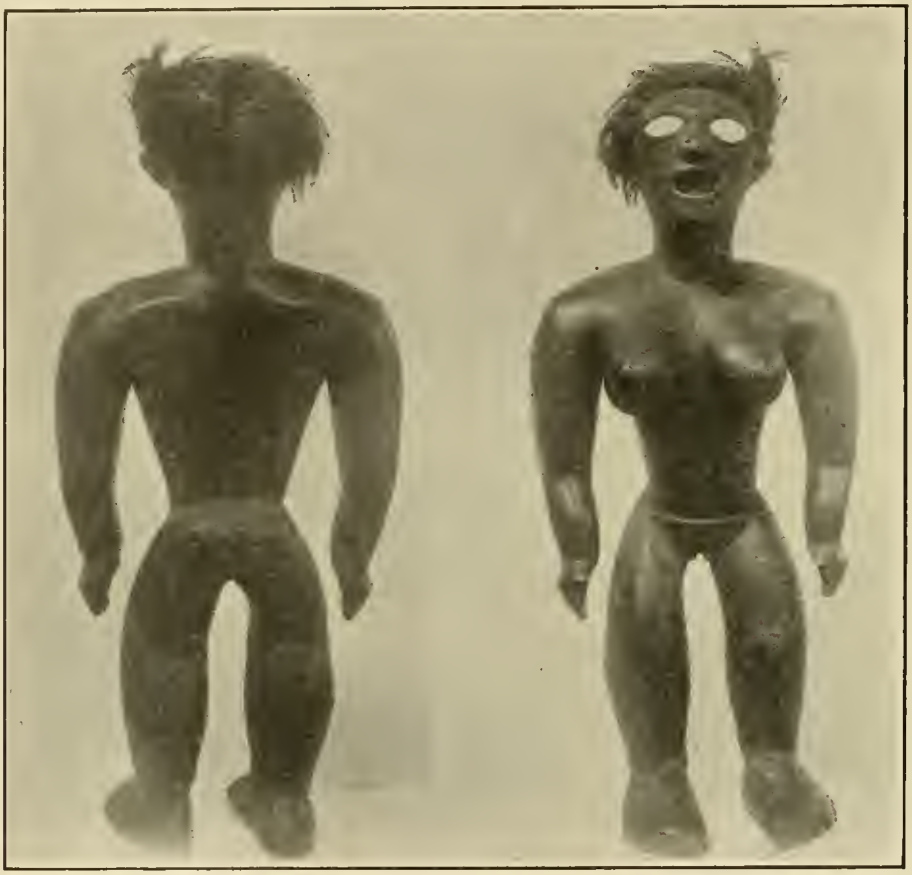
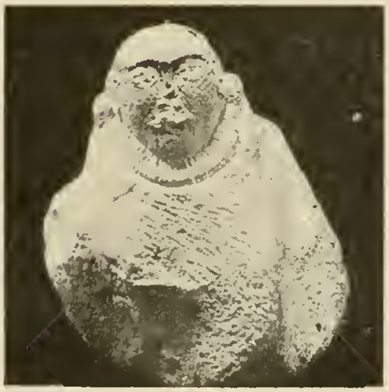


FIG. 3. PORTRAIT STATUETTE OF GIRL.



[1] I am not unmindful of the interesting stone figure already described and figured in the essay on Hawaiian Stone Implements (Mem., vol. i, 4, p. 95), but that, if not of foreign workmanship, was a portrait of a foreigner. All that is known of this curious bust is given in the essay referred to, but the illustrations may be repeated here to show the contrast to genuine native work.

correct, they are the finest specimens known of Hawaiian portrait work. The measurements and description are as follow:—

1. Height 28 in.; breadth of shoulders 12.3 in. Dark wood well polished. Vulva carefully carved, breasts conical. Teeth of lower jaw inserted as one piece of light colored wood. Hair neatly pegged in the usual way, reddish and very brittle. Eyes of shell, right with peg hole drilled, left entire and more recent.

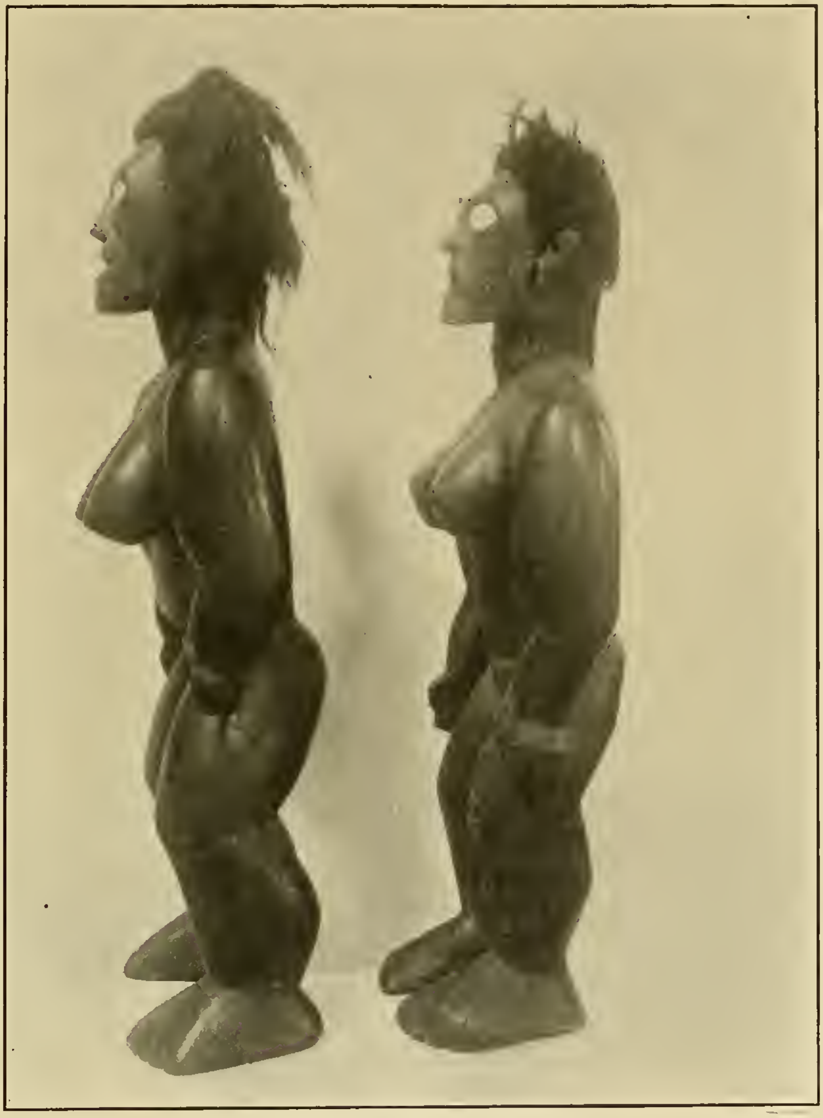


FIG. 4. STATUETTES IN PROFILE.

2. Height 27 in.; breadth of shoulders 11.2 in. Hands and ears better finished than in No. 1. Breasts hemispherical. Vulva deep cut, with deeper hole. Mouth open with hole at bottom as if to attach tongue. Eyes pearl, without holes. Hair pegged in with some fibrous wood. Same wood and workmanship as No. 1.

Beyond the limitation of insufficient tools and primitive methods there is a type seen in all Hawaiian sculpture which is strongly developed here. In addition there is a freedom and individuality in these little statues, which are doubtless from the same hand and of the same date, seldom seen in the images of the gods. The relative age of the two subjects is shown not only in the breasts but is most strongly marked in the facial features. The limbs are rendered much truer to nature than usual, with less of the elephantine form, fully separated, and the balance is so well preserved that the images stand firmly on their feet. When found each image had on an apron of kapa.

The hair, which in its unkempt state gives a wild though realistic effect to the figures, is the usual coarse hair of the Hawaiian, in these specimens of a reddish tint, whether from coral lime dyes or from decay I cannot say, but the hairs are certainly very brittle. The method of attachment to the head is that commonly used in Hawaiian figures, viz.: a hole, round or square, is made in the head; a lock of hair is bent in the middle and the bend inserted in the hole and driven home by a flat wedge which is finally cut to be flush with the general surface and the hairs are thus held securely without any cement. These holes are distinctly seen on the back of the head of the first figure where the hair seems to have broken off but not come out. The empty square holes are more plainly shown in the carved bowl (Fig. 7). The eyes are of flat pearl shell, large and held in place without cement. Only one has been drilled, although it was common, especially in the feather and wicker work heads, to drill a rather large hole through which a round head peg held the shell fast and served to give the expression of a pupil to the eye. The Maori made a similar eye of paua shell, but the central peg was usually an integral part of the head. The older woman has a block of artificial teeth inserted in her lower jaw, a curious deviation from the method used in many of the god images of inserting dog teeth. I have never seen human teeth used in this way, although in one idol in this Museum (No. 7658) there are cavities in the mouth larger than would be

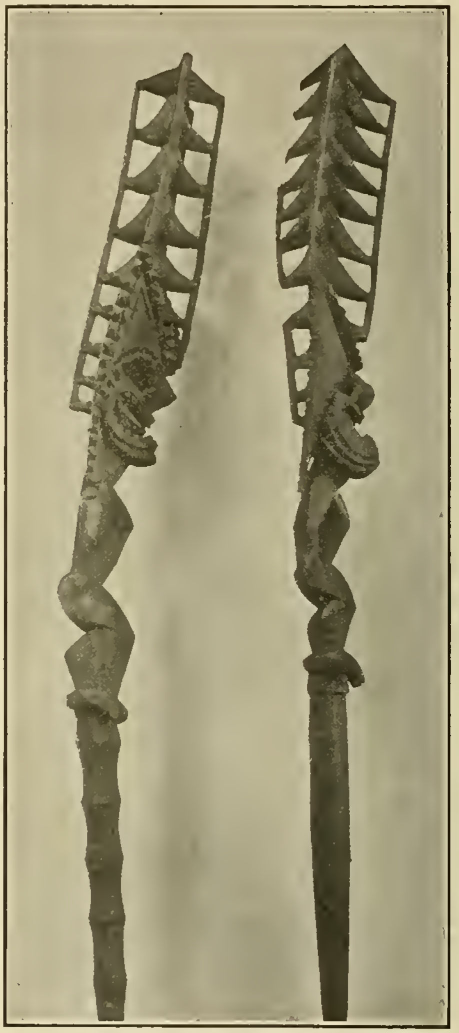


FIG. 5. SIDE VIEW OF AUMAKUA.

required for ordinary dog teeth. The younger woman has a hole drilled in the back of the mouth perhaps for attaching a tongue. The waist, especially in the younger woman, is contracted, and there is a curious ridge between the abdominal and pubic regions. This ridge is also shown in an image in the Museum (No. 7656) which may be a poor attempt at a portrait. In the Museum figure the hands are better wrought than in either of the female images here figured; the breasts are well modeled and show the large Hawaiian nipple. The calf of the leg is, however, affected with elephantiasis, and the balance is destroyed. The head is remarkably brachycephalic, the ears small and high, nose prominent and curved, mouth open and with thin lips, no signs of teeth or tongue. The eyes were of shell and the holes for the attaching pegs are neither central nor symmetrical. The holes for attaching the hair are of the rudest form, and while the hair is gone the pegs generally remain. Another anatomical feature seldom shown is the diaphragmatic line separating chest from abdomen. This image was for many years in the cabinet of the American Board of Commissioners for Foreign Missions at Boston.

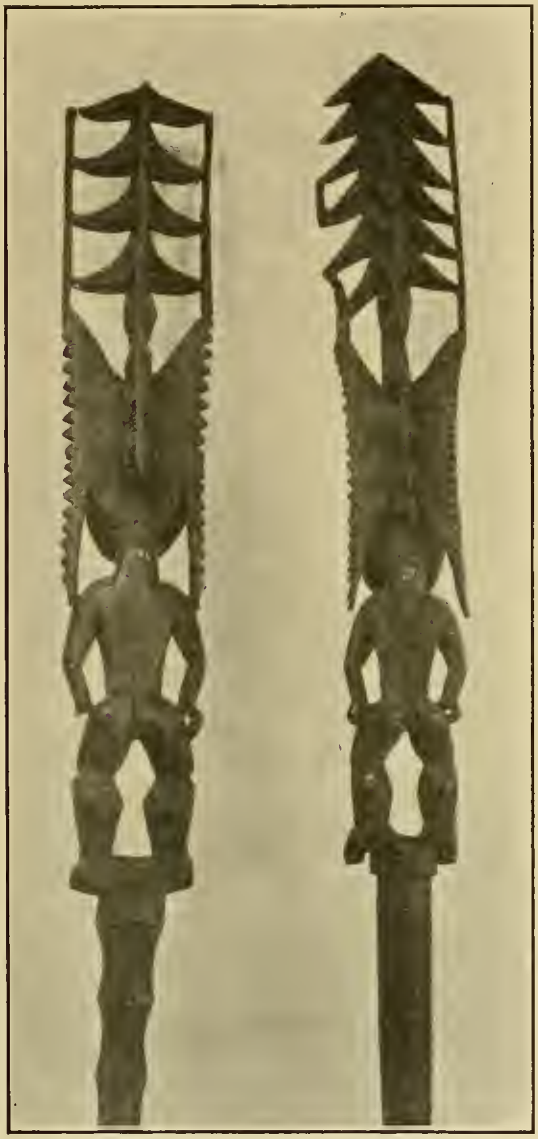


FIG. 6. BACK VIEW OF AUMAKUA.

I can hardly say why, but these two female figures remind me strongly of the old-fashioned figureheads of ships,[2] which, however, often had less expression than these, and it is quite possible that the native artist had lessons from some European or American sailor, for I should hardly place these carvings earlier than the early part of the nineteenth century, or possibly the last decade of the eighteenth.

At the time of the destruction of the idols, after the kapu was broken, many carved figures, mostly grotesque, were doubtless hidden by the devout priests from the mob violence that generally accompanies such changes; witness the terrible destruction of architectural statues, even tombs and painted glass in "civilized" countries during the reformation. But more important was the custom of depositing in some cache the especial property of a departed chief. Not by any means with his remains to which they might serve for identification, a thing to be most carefully avoided, as we shall see below, but in some cave (*puoa*), possibly on another island from that which concealed his bones, such deposits being left in the care of a *kahu* who would generally appoint his successors, and while in the early days of the Christian mission on these islands, the converted kahu would perhaps bring an idol from its place of concealment to serve as offering to his new spiritual father and proof of the sincerity of his conversion,[3] generally the secret of the place of deposit was faithfully kept. I have known of several traditionary caves of which the entrance was carefully concealed, and although the kahu was known, nothing would induce him (or her) to disclose the secret.

---

[2] I have compared them with photographs I once took at Nantucket of a number of these figureheads, once the pride of shipowners, now discarded by a changing fashion, and while I cannot trace the least resemblance to individual figures, the impression remains.

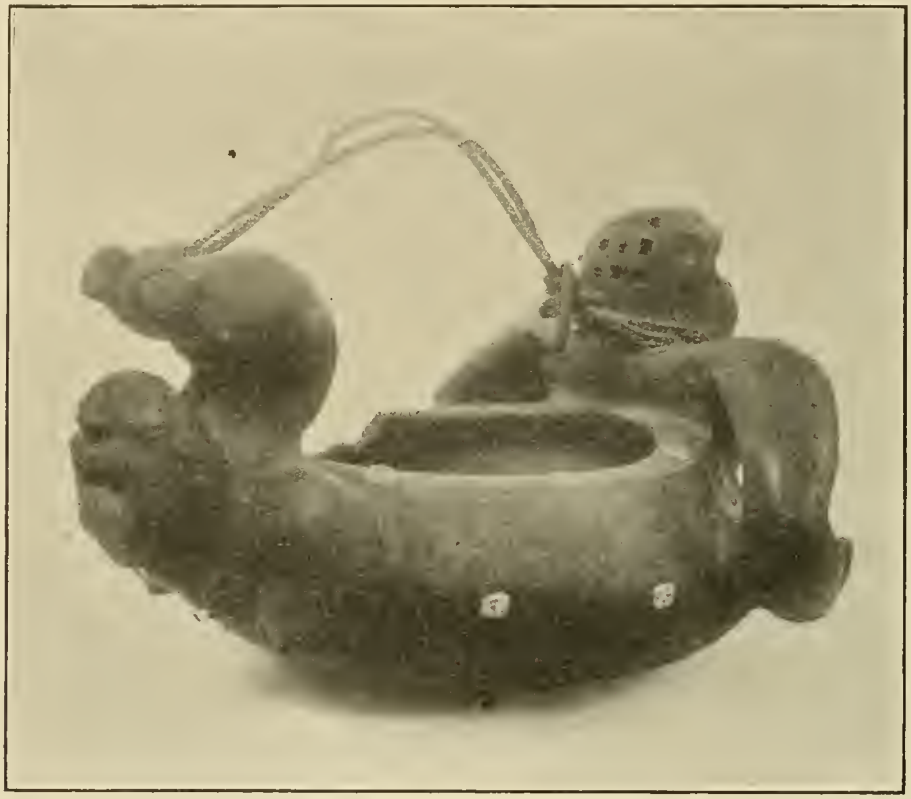


FIG. 7. CARVED BOWL.

---

[3] The war god of the great Kamehameha, Kukailimoku (Mus. No. 7855) figured in the essay on Hawaiian Feather Work, Memoirs, vol. i, p. 32, fig. 22, was thus given to the missionary, and it is probable that the image (Mus. No. 7656) was a similar offering.

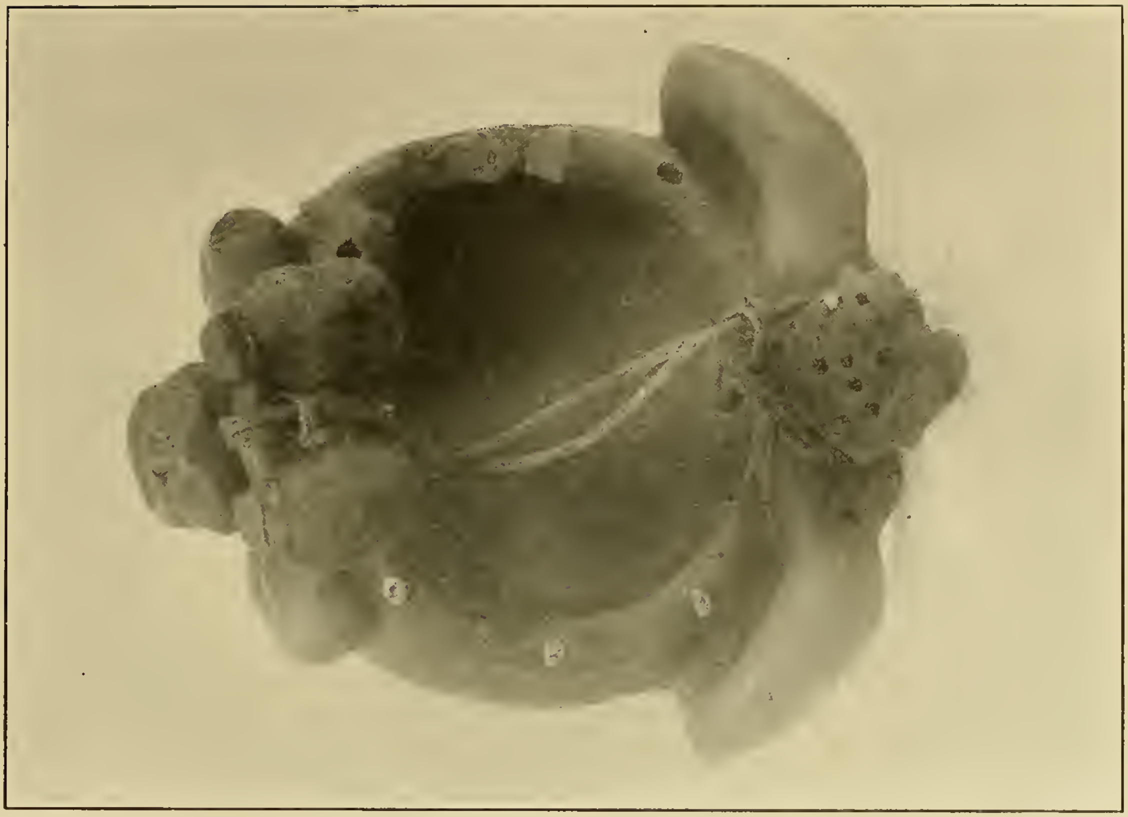


FIG. 8. INTERIOR OF CARVED BOWL.

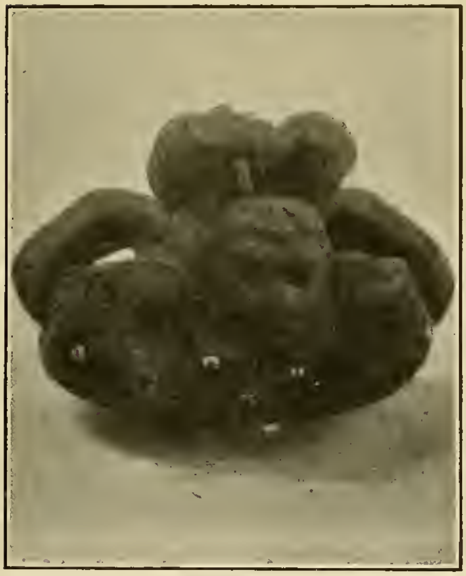


FIG. 9. ONE END OF CARVED BOWL.

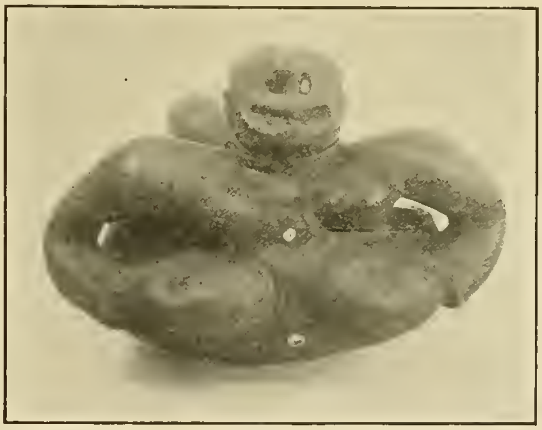


FIG. 10. OTHER END OF CARVED BOWL.

The late king Kalakaua was especially anxious to learn of such deposits, and he once described his visit to a cave near Kealakeakua on Hawaii, where he had to dive to a hole in the cliff above the bay and then come up through a sort of well, and when torches were lighted he saw huge wicker figures of gods, a canoe and other things. He told me he would not enter that cave again for all the kingdoms of the Earth. At another time he persuaded a very old man, the kahu of a puoa on Kahoolawe, to show him the entrance. The old man knew that he should die as soon as he parted with the secret, but he was old and weary of life and proud to die for his king. Kalakaua was very eager, but the kahu then told him that the man who opened it would die too. Not being weary of life, the king came to me and begged me to go and open the puoa for him. I asked if he was anxious to kill me: and he answered (in the general belief of his people) that the predicted fate had power only over Hawaiians. We went so far as to make an agreement as to the partition of the things that might be found, but the king's departure for the coast of California, where he died, put an end to the adventure, and the old kahu soon after died also.

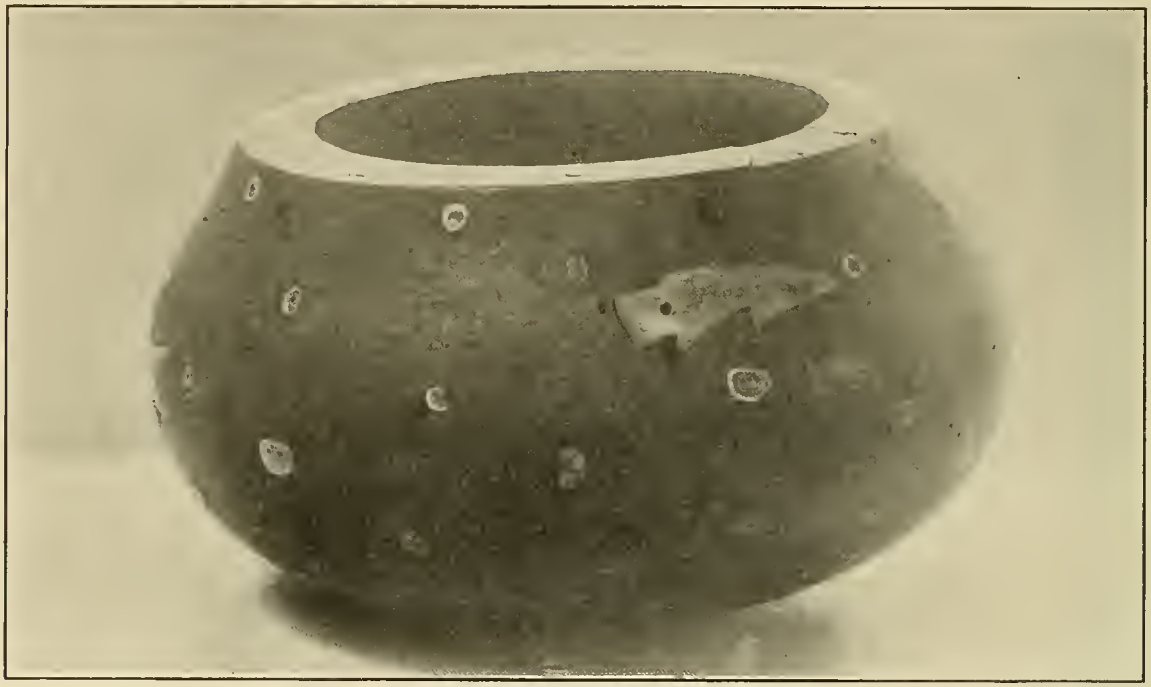


FIG. 11. INLAID IPU AINA.

Although many of the objects in the Bishop Museum came from such deposits, in very few cases is the locality known. As an illustration of the care exercised by the kahu over his hidden treasures, I may mention a cave in Kau discovered by accident. Late one afternoon while the road from Kilauea to Punaluu was being broken out, a cart crushed through into the cave beneath the roadway. It was found to contain many articles, but the day was so far spent when the workmen had extricated the cart and horses that they left further exploration for the next morning. They returned to work very early, but the cave was empty. Doubtless the kahu had removed the deposit from the opened cave to another in the neighborhood: caves are common enough in that region.

The Papa kupalupalu manu (two platters on which human flesh was used for shark bait) of Alapai nui (died 1754) were in a puoa in Puuanahulu, North Kona, Hawaii, when the lava flow of 1868-69 threatened their destruction. The cave was buried in the advancing stream, but the platters were removed to the house of the kahu in Kaupulehu where they were preserved until April 8, 1883, when the last of the kahu, an old woman, died. They were then sold and came to the Museum, where they bear the numbers 157-158.

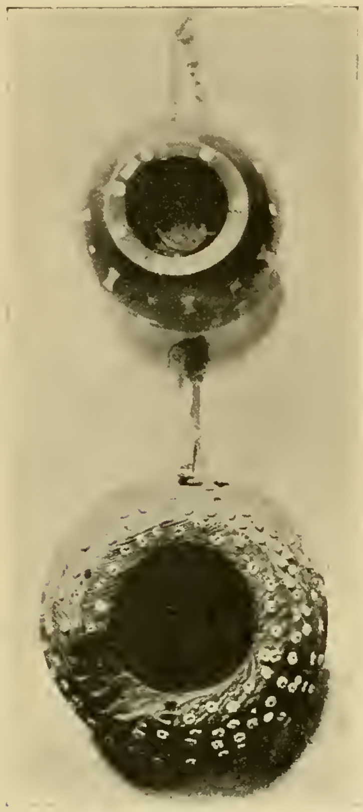


FIG. 12. INLAID IPU AINA IN BISHOP MUSEUM.

A stone idol (Mus. No. 4898) was found in blasting while road making; the blast opening a small cave which was nearly filled by the image; this was secured at once before any possible kahu could intervene. It is well known that a house at Kailua, Hawaii, where Kamehameha died May 8, 1819, was filled with his personal property and made kapu. What became of these kapued things after the cessation of the kapu I do not know, but he left several widows.

3 and 4. Next in the list come the two aumakua or household gods. In these the intricate carving almost rivals the beautiful *rapa* (stern of a war canoe) of the Maori carver, and is sufficiently shown in Plate XVII and Figs. 5-6. The immense mouth and plentiful teeth are usual characteristics of divine images, but the elaborate head dress is by no means common, or on any of these images preserved in museums. What it signifies I do not know, nor are there any natives here who can or will tell. The terminal rod was almost universal and served to support the figure on a pile of stones, on a heap of offerings, or in the ground while prayer was addressed to it. These aumakua are fresh and unsoiled and have evidently been carefully preserved; probably they have never been exposed to the weather. They show no sexual attributes except the absence of mammæ, and it may be noted here that no male figure was found in this cave. The measurements are:—3. Height 26.7 in. from base of feet to top of head dress; from feet to end of rod 15.4 in. This rod has four polyhedral

concavities (13 sides). 4. Height 27.7 in. from base of feet to top of head dress; from feet to end of rod 16 in. In this the rod is round.[4]

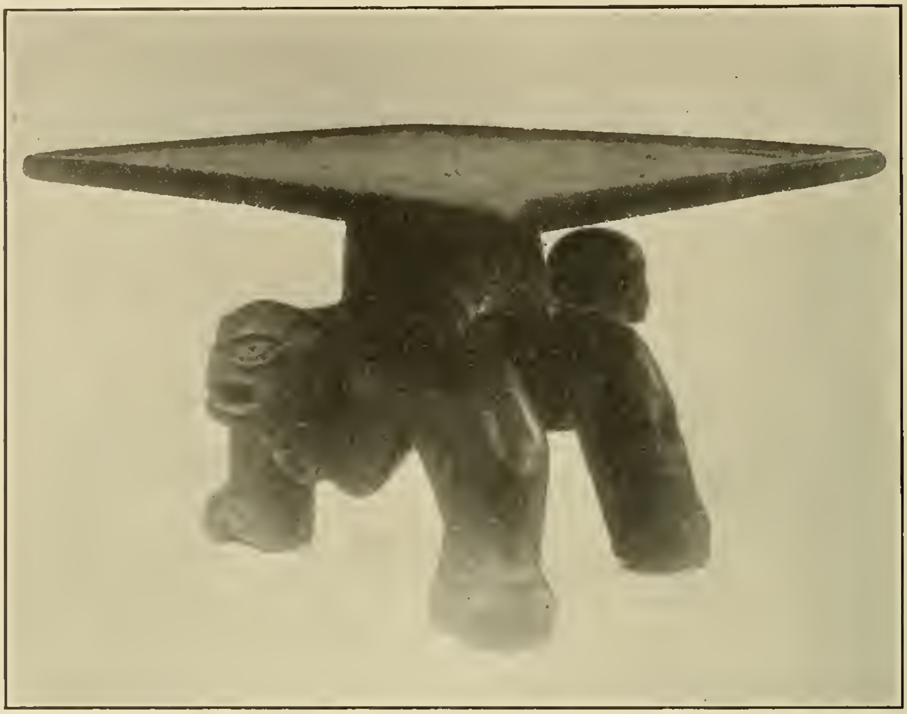


FIG. 13. PAPAMU OR KONANE BOARD.

5. Perhaps the most remarkable carving is the bowl shown in Figs. 7-10. One or two suspended bowls are in the Museum, but their purpose is not well understood and the present example surpasses any Hawaiian carved bowl known in the grotesque originality of the design. The measurements are: Diameter 14 × 10.6 in. Bowl 4.5 in. deep; rim partly broken away; many (20) fine teeth inserted, often to mark points in the figures; larger one with female parts accentuated; nineteen rectangular holes in back of head, ten of them plugged; three teeth on decayed rim gone.

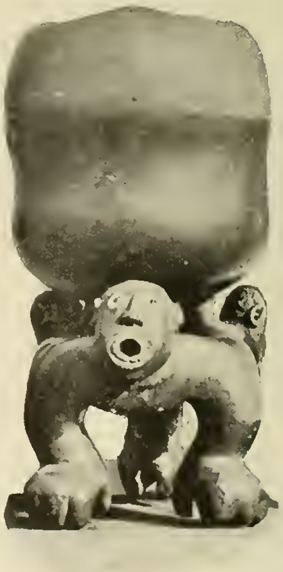


FIG. 14.

I should consider this the most ancient article in the list. It is somewhat decayed and broken, but enough remains perfect to show the great skill as well as imagination of the artist. Apart from the remarkable figures carved on the bowl in the highest relief the attention is caught by the curious method of ornamentation by the insertion of superb human molar teeth. The Hawaiians made great use of the more durable human remains, such as hair, teeth and bones, not only for ornament but for practical purposes. One example of the use we shall see later in this collection; the ornament appears in this and the following bowl. Another curious use of human bones was in the house built at Moanalua, Oahu, of the bleached remains of the men who fell in battle. The use of human bones for fish hooks and arrow points was well known. This disposition of the bones was insulting to the dead and the insult was intentional. This is also shown in the insertion of teeth and bones in vessels of dishonor, such as spittoons (*ipu kuha*), slop basins (*ipu aina*), and the like. Hence the care taken to hide from the enemy the bones of a chief or important person. Placed in a food dish, sacred drum or kahili handle the remains were honored, and examples of all these uses are in the Museum.

---

[4] Had these last images been found in less respectable company, I should have doubted their antiquity, although there is little save their fresh appearance to sustain such doubt. But in subject and treatment there is nothing to arouse suspicion.

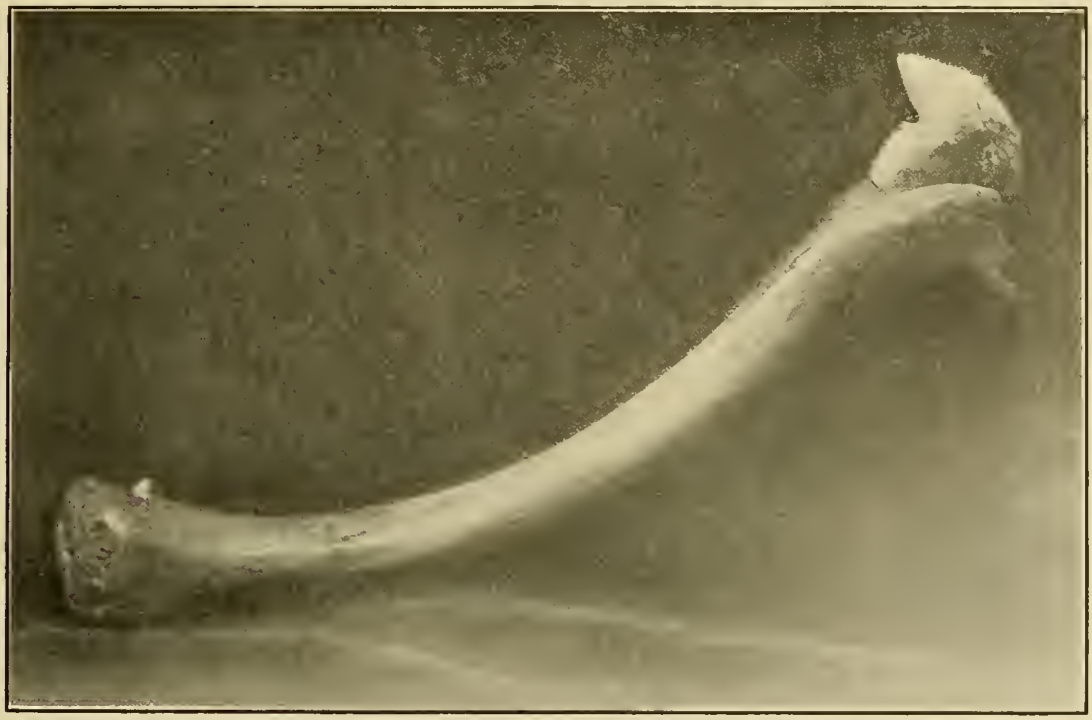


FIG. 15. CARVER WITH HUMAN BONE HANDLE.

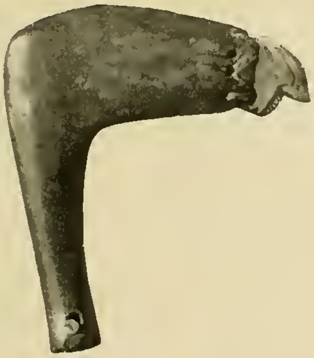


FIG. 16. CARVING TOOL IN BRITISH MUSEUM.

The bowl itself is of the best form, round, and gracefully curved to the flat rim, while the figures grow out of it without obscuring its form in the least. The teeth, gruesome as they are to our otherwise trained taste, do, it must be confessed, break the monotony of the plain sides in a pleasant way, a device well known to the mediæval jewelers in their gem-studded chalices. The figure in an inverted position (Figs. 7, 9) has her ankles connected by a round bar which serves as a point of suspension, the other end of the suspending cord (aha or coconut braid) being knotted around the neck of the opposite figure which is also female. The holes made in the head of this last figure are very neatly cut; the hair and many of the pegs have disappeared. A good bushy wig must have added character to the rather insignificant bald head. Why so much labor should have been expended on a mere ipu aina, a dish to contain the refuse of a feast, such as fish bones or banana peels, is hard to explain, but in the next article of our list we find another ipu aina on which quite as much careful labor has been bestowed. It is of course possible, if not probable, that this figure-handled bowl may have had another if unknown use.

6. As might have been expected in such an assemblage of patrician possessions, there was an inlaid ipu aina. Few of the chiefs entitled to wear feather robes that had not at least one of these convenient trophies of their, or their ancestors', prowess in battle, mementoes of the enemies killed. The one in this collection is shown in Fig. 11, and the dimensions are as follows:—Diameter 10-10.2 in.; height 5.6 in.; teeth 9 on rim, 54 on side, less 4 missing, several half teeth, two decayed; 3 strips of bone; 2 sections of ivory harpoon point from Alaska.

The teeth are all ground down, sometimes showing a section of a root, and while the nerve cavities are large the enamel is remarkably thick. Some of the teeth were decayed, and one has been filled (*post mortem?*) with two narrow pieces of enamel. Some of the teeth are plugged into holes too large. Three strips of bone and two sections of ivory harpoon barbs from the Northwest Coast are added attractions; the harpoon would point to the very early days of the whaling voyages to Bering's Sea when such articles were new to the Hawaiian sailors. It must be remembered that these circular bowls were not turned, but cut with stone tools by the eye alone as guide, and then polished with stones of varying texture.

In the Museum are several of these ipu aina inlaid with bones and teeth, and two of them are shown in Fig. 12. The upper one belonged to Queen Emma's ancestors, and is finished much in the same way as our cave specimen, although with more symmetrical ornamentation. The lower bowl in this illustration was carved from a piece of Oregon pine washed ashore after its long ocean journey, and, as the photograph shows, it is thickly studded with fine molar teeth, a few of them worn down by use in life. It was noted that in the inner portion of the cave where the collection we are describing was found, there were many clean and polished skulls from which all the teeth had been removed.

7. Now we come to a very different class of objects. The game of *Mu* or *Konane* was decidedly an aristocratic game much as chess even among the Egyptians, but I cannot assert that its use was restricted to the alii or chiefs as was the game of *Papa holua* or sledding down hill. It was played on a flat surface marked with points on which were placed black and white stones to serve as "men", the game resembling our draughts or rather the game called fox and geese. Often the flat surface of a natural

stone was used, the "places" being merely dents pounded in the rock. Many of these are to be seen on the ledges to the north of Kailua on Hawaii. At other times a moderate sized flat stone was selected, as No. 5313 in this Museum. The more elaborate were of wood on stands, plain or carved, while the places were marked by the insertion of bones (generally chicken). The present example of a wooden papamu or konane board (Fig. 13) is the only one I have seen with carved figures for supports. In the British Museum is a bowl with similar figures (Fig. 14), and other examples are known, but the curious part of this support is the hollow, cylindrical receptacle (for the men?) from which spring the head and fore quarters, the hands becoming the feet of

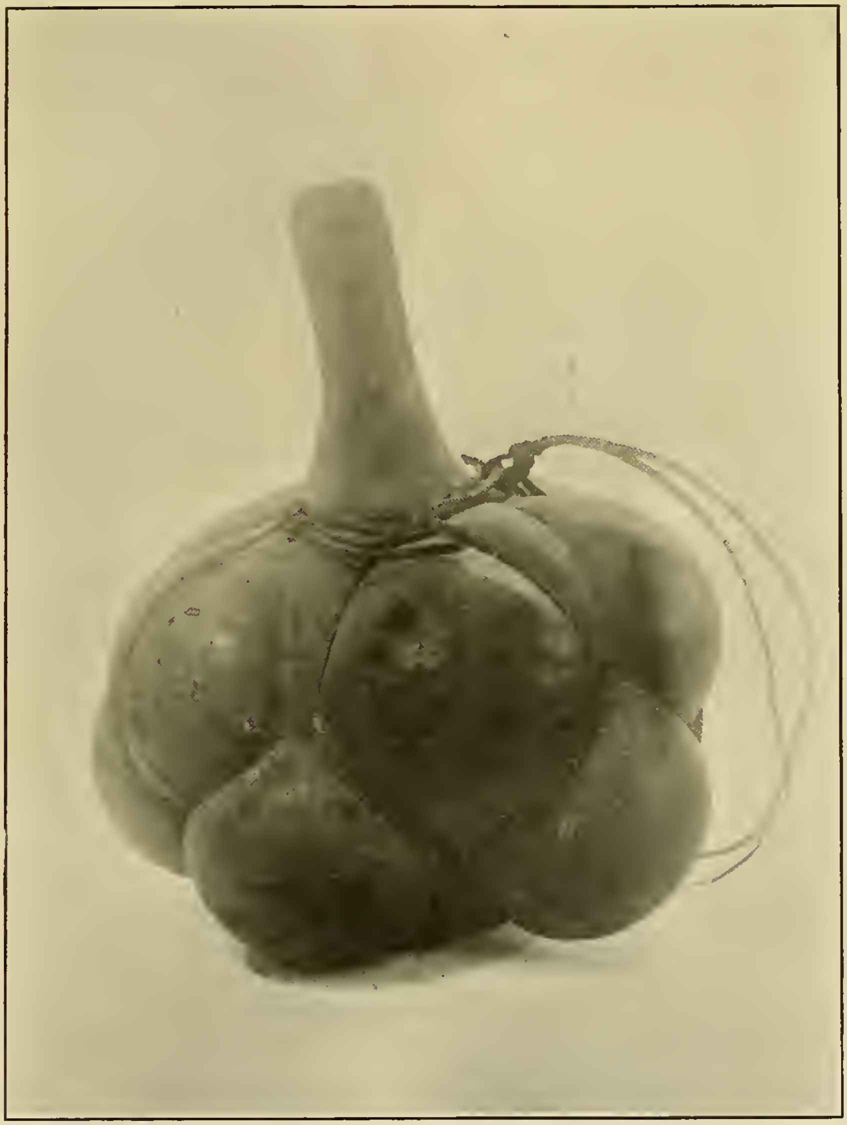


FIG. 17. GOURD WATER BOTTLE, COMPRESSED BY AHA HAWELE.

the papamu. The general dimensions are: Board 13.2×10.2; 156 holes of minute size, not in equidistant lines, about 1 in. apart; rim raised, top 8 in. from base of feet. Of one of the female (?) figures an arm has been attached by a neat mortise and tenon joint, but is now lost. Eyes were probably inlaid with shell. A coconut braid is provided to hang the papamu up with.

The game of Konane or Mu got its more common name from the *Mu* or officer whose business it was to capture the men needed for sacrifice or the ends of justice, and the *papamu* means simply the board or flat surface on which the Mu captures his men. The present example of such a board is the smallest I have seen. The places are marked by tiny borings hardly visible, and are in regular rows and not quincuncial as is often the case.

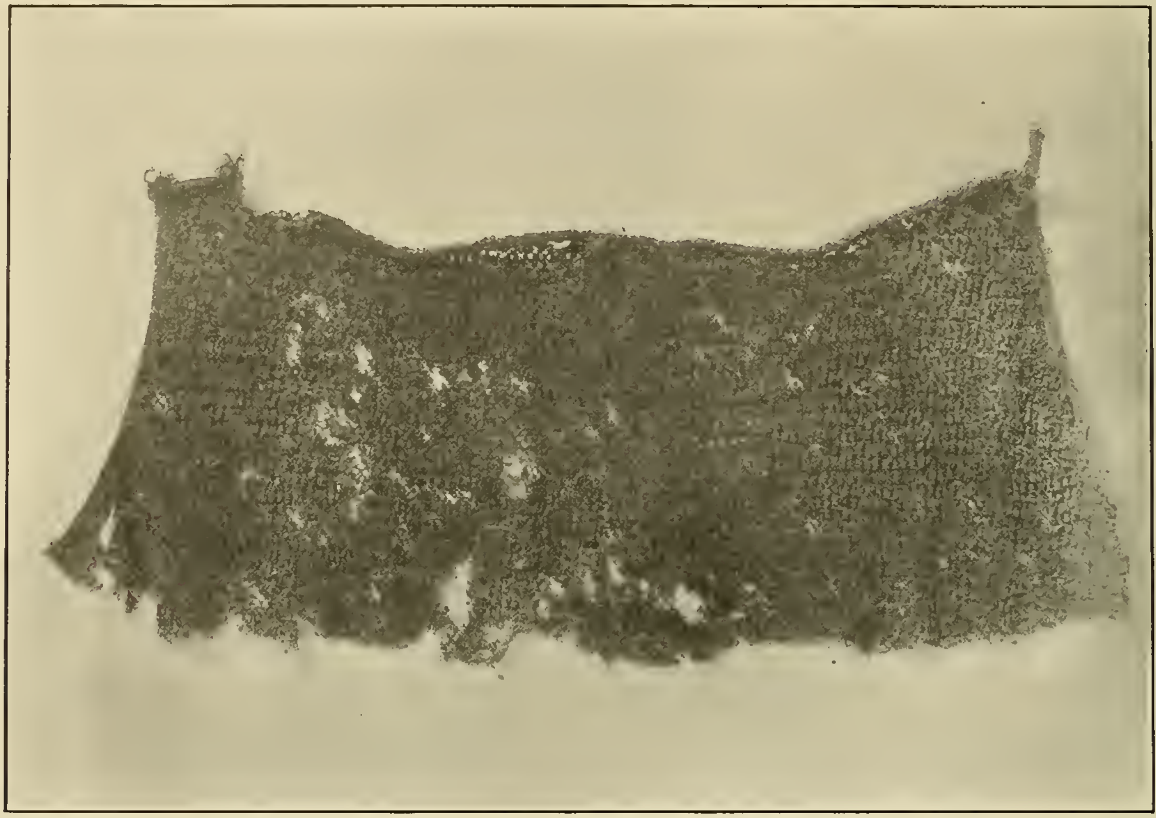


FIG. 18. NET OF FEATHER CAPE.

8. With all these carvings was placed a choice example of the tool with which the carving was done (Fig. 15). Generally, however, while the cutter remains the tooth of a shark, the handle is of wood, or, not uncommonly, the jaw bone of a pig. In our specimen the handle is a human clavicle to which the shark tooth is firmly attached by a single wooden peg. The bone is 5.5 in. long, is well shaped for a handle, and has the remains of a waoke cord by which it could be hung up. Half the lower

jaw of a pig was perhaps a very early form of handle, and the conveniently bent end has been retained in wood, as may be seen in a fine example in the British Museum (Fig. 16). To one who has not tried this tool or seen it used it might appear unsatisfactory, but I have seen it in the hands of old natives as handy a tool as the knife of a Yankee whittler. The best work made with a shark tooth is perhaps the fine diaper pattern on the ceremonial paddles, food scoops, and adze handles of Mangaia, specimens of which are in most large ethnological museums, and which could not be better done with our sharpest chisels. A magnificent example of a Mangaia adze is No. 5939 in this Museum.

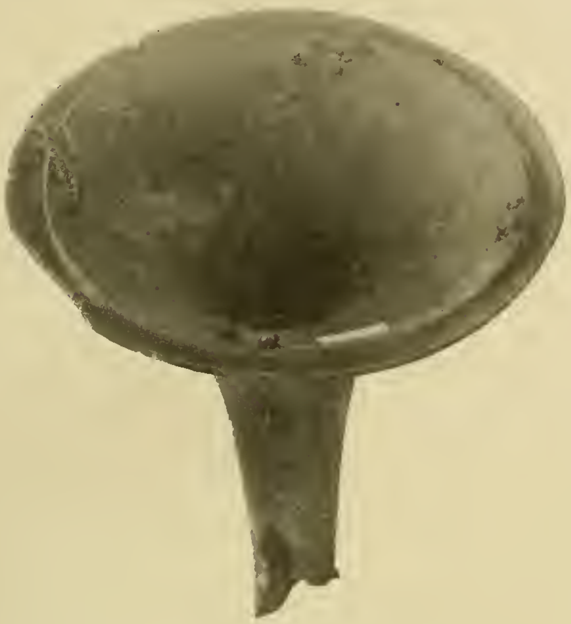


FIG. 19. WOODEN FUNNEL.

9. Ipu wai, a gourd water bottle, the only one I have seen of this form, while not a carving is yet a result of plastic art. The Hawaiians understood well the moulding of the growing gourd (of which they had two species indigenous or of ancient introduction) by suspension or compression, and many beautiful specimens of their skill are preserved in the Bishop Museum, but in the bottle before us the compression has been applied by a tight net work around the body of the gourd after it had attained a considerable size. As will be seen in the illustration (Fig. 17), this has resulted in two rows of five bulbous projections each, which give a remarkably attractive appearance to the bottle, which is 11 in. high and 9.8 in. wide. The present cord upon it is of aha or coconut braid, stiff, brittle and doubtless very old. The gourd itself is thin and cracked.

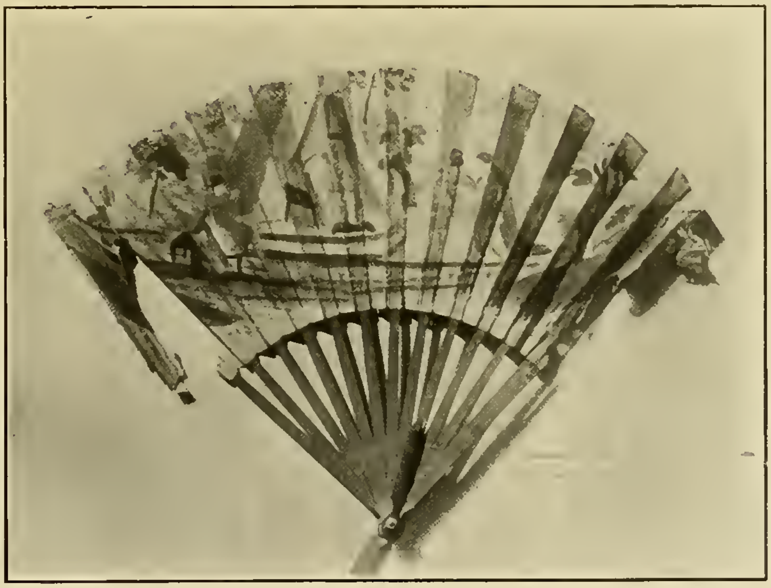


FIG. 20. FOREIGN FAN.

10. Another indication that the property in this cache was once the treasure of a chief is the shabby looking ruin of net work shown in Fig. 18. This was once, however, the net of a much prized feather cape, the peculiar property of the alii. So far as can be determined by the few remains of feathers still attached to their quills, the color was red, by no means so precious as the yellow feathers. The shape is rectangular with a four-square cord along the upper side and remains of neck strings; this neck cord is much worn, and the net seems never to have been finished. The neck measures ±19 in., and the sides 9 and 9.7 in.

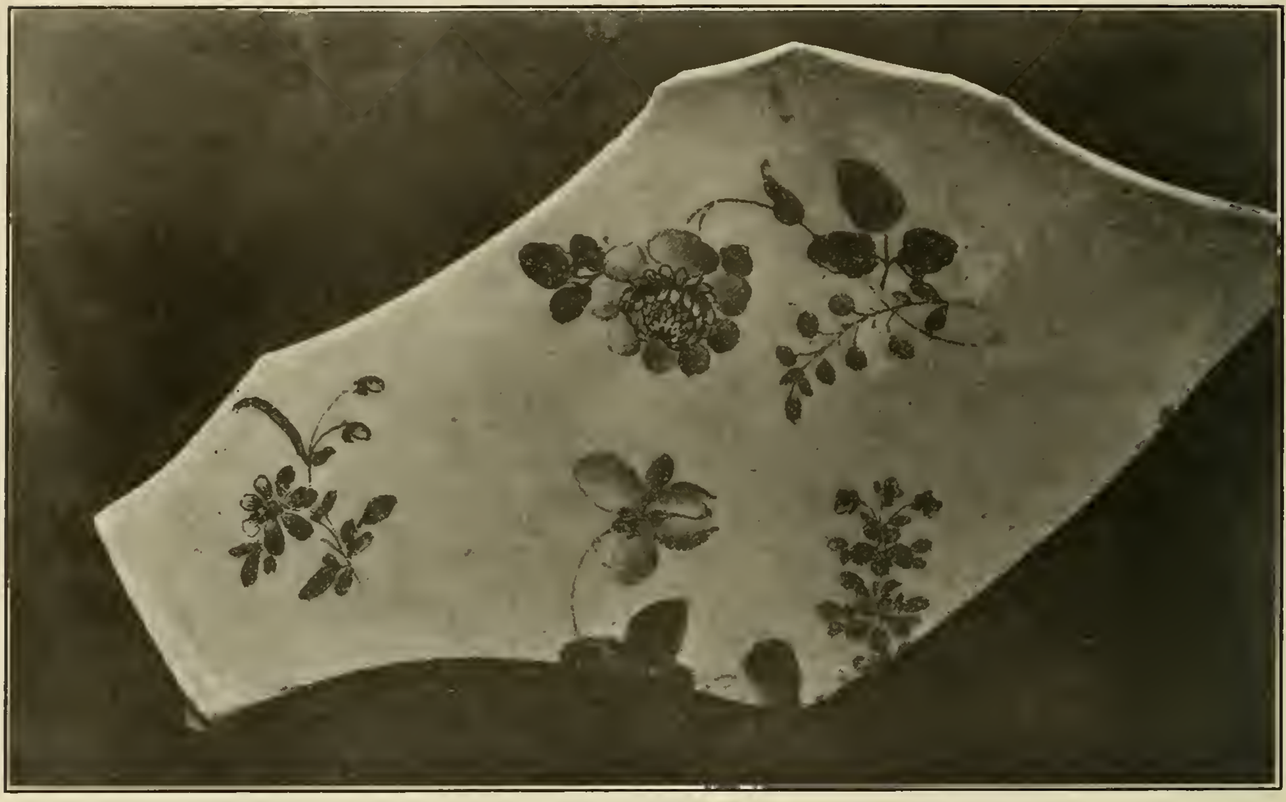


FIG. 21. FRAGMENT OF CHINESE PORCELAIN.

In the cave were also found an ordinary gourd bowl or umeke, some rude trestle work, and a funnel-shaped implement well carved from kou wood, the use of which I do not know. It had been attached to something by the larger end, is there grooved, and has the remains of binding cords. The smaller end is broken. Fig. 19 may suggest to some one a use for this detached funnel. Specimens of the kapa found in the cave have been placed in my hands and will be described later.

With the Hawaiian articles enumerated were found two things that seem worthy of illustration as showing what the native regarded as treasures. The first is a painted fan, nearly in pieces, shown in Fig. 20. The other is a fragment of a porcelain plate shown in Fig. 21.

PUBLICATIONS OF THE B. P. BISHOP MUSEUM.

A Handbook for the Bishop Museum. Oblong octavo, 94 half-tone illustrations. Price 50 cents; postage 9 cents.

Occasional Papers, Vol. I. Octavo.

No. 1. Director's Report, 1898. Visits to Ethnological museums in a journey around the world. Price 50 cents; postage 5 cents.

No. 2. Director's Annual Report, 1899. Mat Sails of the Pacific—Stokes. Ray-skin Rasps—Walcott. Notes on the Birds of Oahu—Seale. Price 50 cents; postage 4 cents.

No. 3. Director's Annual Report, 1900. Visit to the American museums—Stokes. Mission to Guam—Seale. Notes on the Birds of Kauai—Bryan and Seale. Price $1; postage 8 cents.

No. 4. New Hawaiian Fishes—Seale. Price 25 cents; postage 2 cts.

No. 5. Director's Annual Report, 1901, and Index to Vol. I. Illustrations of sperm whale and bird groups. Price 50 cents; postage 4 cents.

Occasional Papers, Vol. II.

No. 1. Director's Annual Report, 1902. Noteworthy Hawaiian Stone Implements—Brigham. Fibres of the Hawaiian Islands—Blackman. Distribution and Variation of Achatinella multizonata—Cooke. Monograph of Marcus Island—Bryan. Price $1; postage 7 cents.

No. 2. Director's Annual Report, 1903. Remarks on Phallic Stones from Rapanui—J. L. Young. Aboriginal Wooden Weapons of Australia—Blackman. Price 40 cents; postage 4 cents.

No. 3. Director's Annual Report, 1904. Australian Bark Canoe—Brigham. A Stone Dagger for Duelling—Brigham. Notes on the Birds of the Waianae Mountains—Bryan. Additional Notes on the Nesting Habits of the Hawaiian Owl—Bryan. Description of the Nest and Eggs of Chlorodrepanis virens (Gmel.)—Bryan. Notes on the American Birds Collected in the Hawaiian Islands by Mr. Gerrit Wilder—Bryan. A Bird's Nest of Pele's Hair—Bryan. Two Undescribed Nests and an Egg of a Hawaiian Bird—Bryan. Price 50 cents; postage 5 cents.

No. 4. Director's Annual Report, 1905. Old Hawaiian Carvings—Brigham. Three New Hawaiian Fishes—Bryan. Report of a Visit to Midway Island—Bryan. Nest of Hawaiian Hawk—Bryan. In press.

Occasional Papers, Vol. III. Reprints of Original Descriptions of Achatinellæ. By E. W. Thwing. In press.

Occasional Papers, Vol. IV. Fishes of the South Seas—Seale. In press.

Memoirs, Vol. I. Quarto.

No. 1. Hawaiian Feather Work. By Wm. T. Brigham. Price $2.50; postage 14 cents.

No. 2. Index to the Islands of the Pacific. By Wm. T. Brigham. Price $1.50; postage 20 cents.

No. 3. Key to the Birds of the Hawaiian Group. By Wm. Alanson Bryan. Price $1.50; postage 13 cents.

No. 4. Ancient Hawaiian Stone Implements. By Wm. T. Brigham. Price $2.50; postage 20 cents.

No. 5. Supplement to Hawaiian Feather Work, with Index to Vol. I. By Wm. T. Brigham. Price 75 cents; postage 8 cents.

Memoirs, Vol. II.

No. 1. Hawaiian Mat and Basket Weaving—Brigham. Hawaiian Nets and Nettings—Stokes. Price $3; postage 20 cents.

No. 2. Old Hawaiian Carvings—Brigham. Price 50 cents; postage 5 cents.

14372

MEMOIRS

OF THE

BERNICE PAUAHI BISHOP MUSEUM

OF

POLYNESIAN ETHNOLOGY AND NATURAL HISTORY

VOL. II—NO. 3

The Ancient Hawaiian House

BY WILLIAM T. BRIGHAM, A.M., Sc.D. (Columbia)

HONOLULU, H. I.
Bishop Museum Press
1908

BOARD OF DIRECTORS

Henry Holmes	President
Albert F. Judd	Vice-President and Secretary
Joseph O. Carter	Treasurer

Samuel M. Damon, William O. Smith, E. Faxon Bishop
J. M. Dowsett.

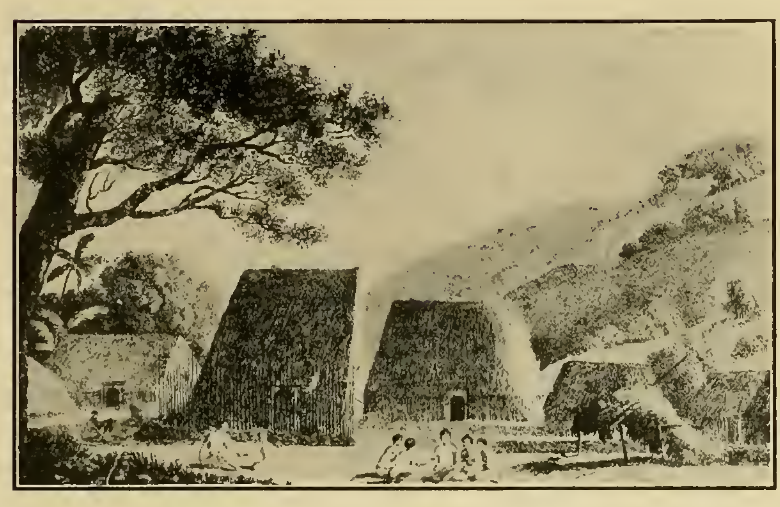
MUSEUM STAFF

William T. Brigham, A.M., Sc.D. (Columbia)	Director
William H. Dall, Ph.D.	Honorary Curator of Mollusca
John F. G. Stokes	Curator of Polynesian Ethnology
C. Montague Cooke, Jr., Ph.D. (Yale)	Curator of Pulmonata
Otto H. Swezey	Honorary Curator of Entomology
Chas. N. Forbes	Assistant in Botany
Miss E. Schupp	Librarian
John W. Thompson	Artist and Modeler
John J. Greene	Printer
A. K. Williams	Janitor
Moses Kauahi	Assistant Janitor

JUL 6 1908

THE ANCIENT HAWAIIAN HOUSE

BY WILLIAM T. BRIGHAM, A.M., Sc.D. (Columbia).



MEMOIRS OF THE BERNICE PAUAHI BISHOP MUSEUM
OF POLYNESIAN ETHNOLOGY AND
NATURAL HISTORY

Volume II, Number 3

HONOLULU, H. I.
Bishop Museum Press
1908

LIST OF PLATES.

XVIII. Pagopago Harbor near entrance. Photo. by Josiah Martin.
XIX. King's house at Mbau, Fiji. Waitovu village, Ovalau, Fiji. J. W. Lindt.
XX. Na Kali, Viti Levu Bay, Fiji. Fijian house with fence at door. J. W. Lindt.
XXI. Maori carved house.
XXII. Maori carvings.
XXIII. New Hebridean huts.
XXIV. Communal house, New Guinea.
XXV. High house, New Guinea.
XXVI. Hawaiian house framing.
XXVII. Hawaiian house thatching.
XXVIII. Hawaiian house completed.
XXIX. Hawaiian cords.
XXX. Ipu holoi lima.
XXXI. Ipu aina with inserted teeth.
XXXII. Ipu kuha = Spittoons.
XXXIII. Gourd bottles for fish lines.
XXXIV. Hawaiian stirrers and knives.
XXXV. Carved articles from Hawaii in the British Museum.
XXXVI. Na ipu pawehe: decorated gourd vessels.
XXXVII. Carved coconuts.
XXXVIII. Hawaiian umeke laau No. 9530.
XXXIX. Umeke.
XL. Umeke.

ILLUSTRATIONS.

PAGE
1. Honolulu from the foot of Punchbowl in 1837. 5
Drawn by Edward Bailey 3
2. Marquesan village: Voyage de la Venus, Pl. 20.
3. House of the Tahitian queen 6
4. Tahitian village. Photo. J. Martin 7
5. Parkinson's drawing of a chief's house 8
6. Tongan interior: from Voyage de l'Astrolabe, Pl. 75 9
7. Tongan pillow in Bishop Museum 11
8. Wood stools in Bishop Museum 12
9. Drinking kava in Tonga. Cook, III Voyage, Pl. 20 14
10. Samoan house 15
11. Samoan interior 16
12. Samoan palace 17
13. Samoan pillows 17
14. Samoan house completely open 18
15. Samoan temples: from Stair 19
16. Interior of NGaraningiou's house 20
17. Modern Fijian house 21
18. Fijian pillows 22
19. Sections of Fijian houses 23
20. Sinnet ornamentation 24
21. Door of Fijian house to show pent. Presenting a whale's tooth to a chief 25
22. Mbure in Mbau 27
23. Maori hut 31
24. Poupou and Tukutuku in Maori Whare 32
25. A Maori house 33
26. Entrance of a modern carved house 34
27. Teketeko from Maori gable 35
28. Group of gable images in the Bishop Museum. 36
29. Pataka in the Auckland Museum 37
30. Poupou from Maketu 38
PAGE
31. A Maori mythical form on a house slab 38
32. Interior of a Maori house, Rotorua 39
33. Doorway of Pataka 40
34. Central slab of Pataka 40
35. New Zealanders carving a Poupou 41
36. Scene on Atafu. Drawn by T. E. Agate 42
37. Coconut grove and house on Fakaafo 43
38. Large Mariapu at Uteroa 44
39. Interior of Mariapu 45
40. Model of a Maiana house 46
41. Model of a Kusaian chief's house 47
42. Gable of a Kusaian house. Drawn by L. G. Blackman 48
43. Woven walls of a Niue house 50
44. A New Guinea village 51
45. A village street in New Guinea 52
46. Sacred house at Dorei. From D'Urville 53
47. Village on Duau 54
48. House in Milne Bay, New Guinea 55
49. New Guinea pillows 56
50. Long house in New Guinea 57
51. A tree house in New Guinea 58
52. Tree houses in New Guinea 59
53. Club house (Dubu) for young men 60
54. House front in Kiriwina 61
55. A Kiriwina village 62
56. Original type of Aneiteum hut. Lawrie 63
57. Aneiteum hut with reed front. Lawrie 63
58. A village in Malekula. Lawrie 64
59. Thatching a house in the N. Hebrides. Lawrie. 65
60. New Caledonian house 66
61. Solomon Islands house 67
62. Pile dwellings in Fauro Island. Guppy 68
63. An Australian hut 71

PAGE
64. View made on Kauai by Cook's artist Weber. 73
65. Houses of Kalaimoku on Honolulu 74
66. House in which Keelikolani died at Kailua, Hawaii 80
67. Hakakau for suspending calabashes 81
68. Hawaiian pump-drill 85
69. Ball of braided grass 86
70. Polynesian sennit in native rolls 87
71. Diagrams of house forms 88
72. Hale Kamani at Lahaina 89
73. The pou of a house 90
74. Pou from Waialua 91
75. Pou from Waialua; another view 91
76. Diagram of house plan 92
77. Upper end of rafter 93
78. Upper side of lower end of rafter 93
79. Under side of lower end of rafter 93
80. Lower end of rafter 93
81. Junction of rafters 94
82. Junction of rafters and post 94
83. House near Hilo needing new thatch. C. Furneaux 95
84. House in Puna with lanai 96
85. Grass house with net over it 98
86. House with kapu sign before door 100
87. Grass house of the poorer sort. C. Furneaux. 101
88. Hawaiian village on Niihau. W. Ellis 105
89. House on the beach at Kealakeakua in 1888 106
90. Ellis' view of houses at Kealakeakua, 1779 106
91. Village on Hawaii. W. Ellis 107
92. Hale kauila in Honolulu. du Petit Thouars. 108
93. Street view in Honolulu with Kinau in the foreground. du Petit Thouars 109
94. House of Kamehameha V, Waikiki: Hale lama 110
95. House of Kamehameha V at Kaunakakai, Molokai 111
96. House at Kaimu, Hawaii 112
97. Old Volcano House. Painted by H. Hitchcock. 113
98. Maori fire-making 115
99. Hawaiian tools for fire-making 116
100. Poi-making at Halawa, Molokai, 1888 124
101. Uluna or pillows 125
102. Stone pillow from Kilauea, Kauai 126
103. Kapa beaters 127
104. Laau kui kapa 128
105. Laau lomilomi and bath rubbers 129
106. Kukuinut candles 131
107. Stone lamps 132
108. Stone mortar 133
109. Poi board and pounders 134
110. Poi boards 134
111. Bearing the poi of an Alii 135
112. Hawaiian hay dealer in 1864 136
113. Ends of Hawaiian auamo in Bishop Museum. 137
114. Gourd containers 138
115. Bottle gourd: huewai 138
116. Mended ipu 139
117. Gourd box 140
118. Long gourd boxes 140
119. Gourd hula drums 141

PAGE
120. Gourd water bottles for canoes 142
121. Compressed gourd water bottle 143
122. Gourd funnels 144
123. Awa strainer 145
124. Huewai pawehe 146
125. Gourd implements 147
126. Coconut cups 148
127. Coconut spoons and ladles 148
128. Marquesan carved cup of coconut 149
129. Modern coconut cup of the Hawaiians 150
130. Solomon Islands inlaid cup 151
131. Fijian cup and wiper 152
132. Micronesian water bottles 153
133. Solomon Islands coconut bottles 154
134. Coconut tobacco boxes 154
135. Coconut cups of the high chiefs 154
136. Umeke No. 416 155
137. Umeke No. 417 156
138. Umeke No. 410 157
139. Umeke opaka of kou wood, Nos. 6003, 6004. 158
140. Blocks partly shaped perhaps a century ago. 159
141. Opaka or polyhedral umeke, Nos. 523, 462, 488. 160
142. Deep umeke 161
143. Umeke Nos. 469 and 481 162
144. Umeke No. 1049 162
145. Umeke No. 2291 162
146. Umeke Nos. 557 and 433 163
147. Modern turned umeke Nos. 591, 566, 524, 589. 163
148. Comparative size and shape of umeke 162
149. Umeke of kou, Nos. 9199 and 9215 164
150. Umeke of unusual form, Nos. 475, 440, 1143 165
151. Umeke Nos. 537 and 484 166
152. Umeke Nos. 517, 538 and 516 166
153. Umeke No. 4673, with lugs for suspension 167
154. Umeke with cover, No. 420 168
155. Hawaiian pa or dishes 169
156. Lute-shaped bowls 170
157. Large Hawaiian dishes with legs 171
158. Kanoa awa 171
159. Umeke of Kamehameha I 172
160. Dishes with compartments 173
161. Umeke No. 1050 173
162. Carved Hawaiian dishes Nos, 5181 and 408 174
163. Maori dish 174
164. Hawaiian carved dish in Leiden Museum 175
165. Long platters from the Deverill collection 176
166. Long platters 177
167. Broad platters 177
168. Outlines of typical Hawaiian umeke 178
169. Finger bowl in Berlin 182
170. Ipu holoi lima or finger bowls 183
171. Finger bowl with grit holder 183
172. Ipu aina or slop basins 184
173. Hawaiian mirrors, end of eighteenth century. 188
174. Sketch of Hawaiian mirror in British Museum 188
175. Uhi kahiolona: Scrapers 190
176. Ipu le'i for fishhooks and lines 191
177. Hawaiian bow and arrow, and broom 192
178. Wooden stools in Bishop Museum 193

THE ANCIENT HAWAIIAN HOUSE.

Housebuilding of the old Hawaiians: with a description of the articles used in housekeeping. By WILLIAM T. BRIGHAM, SC. D. (COLUMBIA), *Director of the Bernice Pauahi Bishop Museum.*

IN pursuance of my intention to describe, so far as known to me, the life, manners and customs of the ancient Hawaiians, I have described the feather ornaments, stone implements, and mat and basket work, and now come to the dwellings of the early inhabitants of the Hawaiian Group: and in considering this exceeding important matter of aboriginal life I propose to glance briefly at the primitive habitations of some of the other Polynesian groups and of their neighbors of the Papuan and mixed races. While this course will take us from Rapanui in the East of the Pacific Ocean to New Guinea in the West, I will limit my descriptions (where they are not limited by my ignorance of the subject) and illustrations as much as possible to the material which seems in some degree to illuminate the main subject of *Hawaiian* housebuilding.

To the empty dwelling I have found it convenient to add the usual furniture and utensils which are a necessary part of housekeeping, and although "pots and kettles" are absent, Polynesians having neither metal nor earthen ware, we shall find the better class of Hawaiians were provided with many articles of necessity, even of luxury and elegance, although it will be seen that the common people, the *makaainana*, had little furniture for comfort, and only the merest necessities for housekeeping.

Illustrations have been drawn from the early voyages and, where fashions have not changed by the coming of white settlers, from my large collection of photographs of existing dwellings from nearly every part of the Pacific that the photographer has invaded.

PRIMITIVE architecture may be studied in the Pacific region (where the indigenous architecture has always remained primitive), from the habitations of the troglodytes, where man's hand has hardly modified the natural cavities of the rock formation, through the exceeding simple bark lean-to of the Australian, the cyclopean structures of the Metalanim in the Carolines, the imbedded stone cells of Rapanui, the columned halls of Tinian in the Marianes, the trilithon of Tonga, the elaborately carved *whare* of New Zealand, and the ephemeral houses of sticks and grass, plain as possible in the Hawaiian group, picturesque in parts of Micronesia and fantastic in New Guinea.

The temptation is strong to explore and study more fully the curious stone remains found in many places in the Pacific from Rapanui in the southeast to Tinian in the northwest, and although the evidence that these were the work of the ancestors of the races at present found in the great ocean seems preponderant, they need claim only a passing glance here for they, together with the stone temples of Hawaii, belong to religious or monumental constructions, and we are to limit this excursus to those materials that may be explanatory of the origin or affinity of the Hawaiian dwelling.

In Central America we find wonderful structures of stone buried in forests almost as dense as the veil which shrouds their origin or uses, but we recognize that the houses of the people who built and used these temples, palaces, monasteries or charnel houses, and who must have dwelt in the neighborhood, were constructed of more perishable material and have left no record. In Egypt the same is true; the houses of the gods and of the dead are of durable masonry and material, syenite, limestone, alabaster, while the houses of the people, even the palaces of the Pharaohs were flimsily constructed of wood and have perished save in the pictured stories on the walls of the tombs. The American record in the wonderful painted books which doubtless would have given much light on Maya domestic architecture was mostly destroyed by the fanatic priests who swarmed in the invading armies,—deadly foes to knowledge,—may their souls repent the evil they did! Everywhere the same thing is true of domestic architecture in primitive times and in lands with a mild climate; if the people did not dwell in tents they certainly had houses of not much greater durability.

In the Pacific we still have "samples" of the houses which probably have not changed much from the earliest times, but the lumber and building methods of the foreigner are rapidly driving out even these samples from those groups most open to outside influence. On the Hawaiian Islands forty years ago grass houses were very common outside the larger towns, and even in Honolulu they were found on some of the principal streets. In this town in 1837 they were almost universal as seen in a view of Honolulu drawn by the late Edward Bailey from the foot of Punchbowl Hill and engraved at Lahainaluna under the instruction of Judge Lorin Andrews (Fig. 1). Today we have had to gather into the Bishop Museum an ancient house frame, and the tourist may make the usual circuit of the group and never see an example of a genuine Hawaiian house, although in several places Japanese have built grass houses resembling the native work externally.

The boards and plans of the foreigner result in a cheaper, more convenint, and more durable house than those of the olden style, so the latter are passing and it seems desirable to make a record of their existence and nature, and at the same time compare them with other dwellings in our region. No limitation can be made to the strictly Polynesian tribes, for there is more difference between the Maori and Hawaiian houses, both Polynesian, than between the Hawaiian and the New Caledonian, the latter the work of a very different race. It will then be desirable, if not needful, to present to the readers of this essay types of the principal forms of dwelling houses of the Pacific islanders before entering upon the structure, uses and situation of the Hawaiian houses.

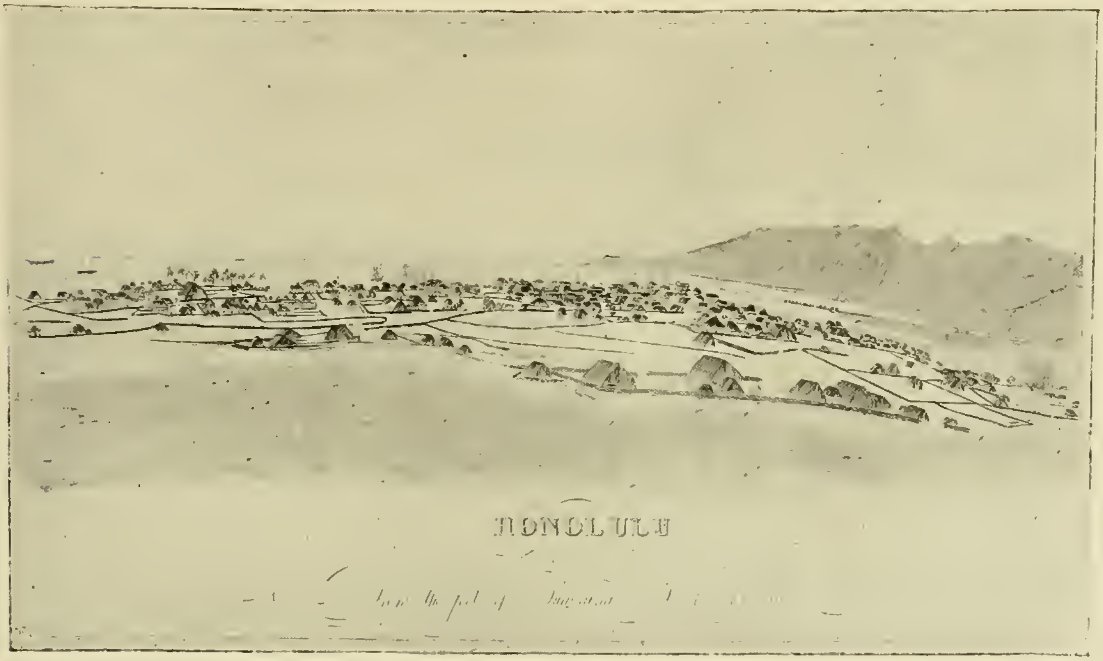


FIG. I. VIEW OF HONOLULU IN 1837.

Even where the material is the same, sticks and thatch, the ground plan varies between island groups while on each group one form is predominant if not exclusive. Thus on Hawaii, Fiji, Tahiti, New Zealand and New Guinea a rectangular plan prevailed, on Samoa and Tonga the ellipse and in New Caledonia the circle were preferred. The Hawaiians certainly built temples with a circular ground plan, but so far as can be learned never a dwelling house. Single habitations were more common in the East, communal in the West of the Pacific region, yet in Hawaii the hospitality of the people made their private home almost a caravansary. In some groups, as in Hawaii, an establishment of a chief or well-to-do man consisted of several detached houses each for an especial use; in others there were houses (or cages) for girls of marriageable age; in others guest houses; and common to many groups were the lodging houses for unmarried males.

The material for a study of the oldest habitations of the Pacific immigrants must be gathered from the accounts, sometimes excellent, of the old voyagers and in these we shall find little change through the century these voyages practically cover, for the early Spanish and Portuguese explorers have not given sufficiently definite descriptions of the houses of the people they discovered. As the good descriptions of houses are scattered through accounts of voyages not always accessible, it seems well to transcribe them here with such illustrations as the authors have given us. In some cases, as in the accounts of the Marquesan houses it would seem possible to reconstruct the homes of the fine natives who have long since disappeared from the beautiful valleys where they once thronged to their cannibal feasts.

In the voyage of the Duff,[1] the first missionary expedition to the Pacific from England, are given detailed accounts of the houses in Tahiti, Tonga and the Marquesas which will be here reproduced from that very interesting volume. On page 131 we find this account of a Marquesan house on the island of Santa Cristina (Tahuata):

> To convey an idea of what this and all their best built houses are like, it is only necessary to imagine one of our own of one story high with a high peaked roof; cut it lengthwise exactly down the middle, you would then have two of their houses, only built of different materials. That we now occupied was twenty-five feet long and six wide, ten feet high in the back part, and but four in front; at the corners four short stakes are driven into the earth, on which are laid horizontal pieces, and from these last to the ground are bamboos neatly arranged in perpendicular order, about half an inch distant from each other; and without them long blinds made with leaves are hung, which make the inside very close and warm; the door is about the middle on the low side. They do not use the leaves of the wharra [Pandanus] tree here for roofing, as at Otaheite, but common broad leaves which they lay as thick as to keep the water out; but the greater part of their houses are miserable hovels. The inside furniture consisted of a large floor mat from end to end, several large calabashes, some fishing tackle, and a few spears; at one end the chief kept his ornaments which he showed to us.

A generation later the Marquesans were visited by a more observant missionary whose account of the houses, while showing that the style remained the same, leaves little to be desired. The Rev. C. S. Stewart, well known on these islands, wrote as follows:

> The houses—though of very different sizes, from twenty to one hundred feet in length, from eight to sixteen in height, and from ten to fourteen and sixteen in breadth—are all of one shape and style, and vary materially in their form and construction from those of the Sandwich Islanders.
>
> Here the roofs, instead of descending to eaves on both sides of the ridgepole, have rafters in front only, while the back of the house descends perpendicularly, or in very slight inclination, from the peak to the ground—giving to the exterior the appearance of an ordinary hut cut lengthwise in two. They are universally erected, so far as I have observed, on a platform of rough, but in many

---

[1] A Missionary Voyage to the Southern Pacific Ocean, performed in the years 1796-1798 in the Ship Duff commanded by Captain James Wilson. Compiled from Journals of the Officers and the Missionaries; and illustrated with Maps, Charts, and Views drawn by Mr. William Wilson and engraved by the most eminent Artists, etc. London, 1799.

cases massive stone-work, from one to four feet in height, which extends two or three feet beyond the area of the house. The rafters descend in front to a plate or timber extending the whole length of the house, supported by a row of thick round pillars, from three to five feet in height, over which the eaves project sufficiently to screen the entrance from the weather.

At the peak the rafters rest on a similar stick of timber, supported by two or more posts, from eight to fourteen feet in height. The space between them is filled with poles of bamboo, or of the light wood of the hibiscus, laid parallel, two or three inches apart over which lighter sticks are placed horizontally, at regular intervals; the whole being neatly lashed together at the points of intersection.

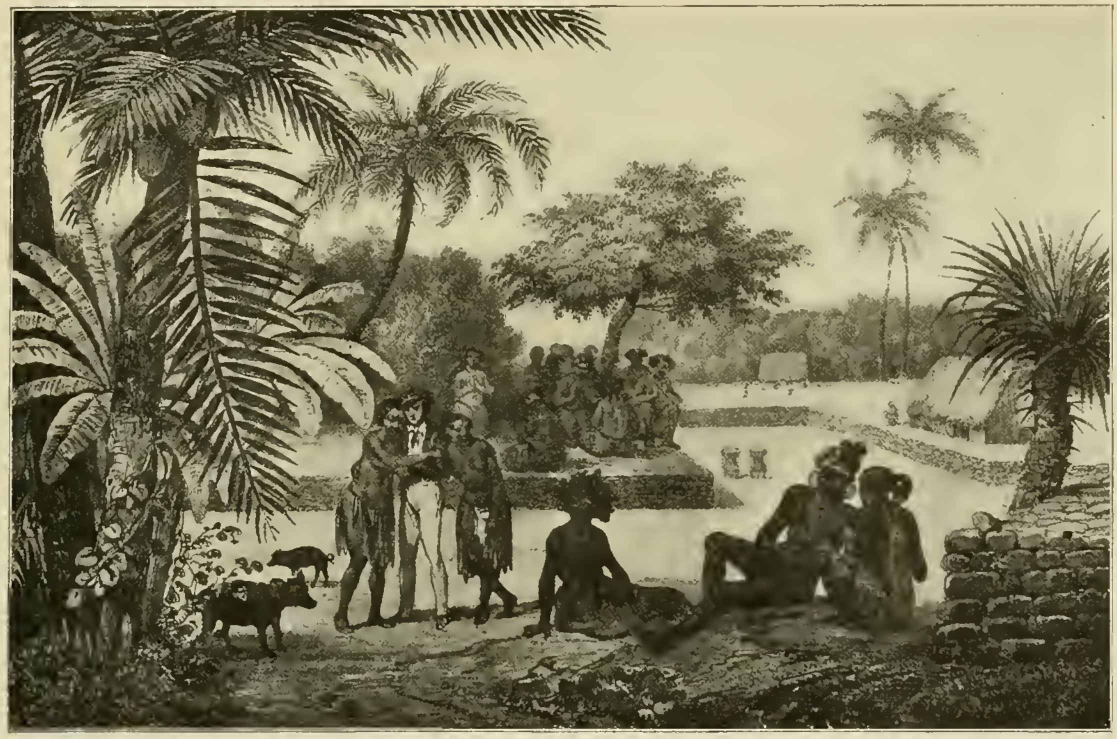


FIG. 2. MARQUESAN VILLAGE (FROM VOYAGE OF THE VENUS, PL. 20).

The back and ends are filled up in the same manner, and thus prepared for the external covering. This is of thatch composed either of the leaf of the breadfruit tree, the cocoanut, or palmetto, *Chamærops humilis* [*Pritchardia pacifica*]—all of which are prepared for this purpose in different methods. The cocoanut leaf is from twelve to sixteen feet long and deeply feathered on either side of the rib running through the middle of it. This rib or stem is split from end to end, and the leaflets on each braided closely together, forming a matting of that length, and one and a half or two feet in breadth. Thus prepared, they are placed on the rafters double, the higher ranges lapping over the lower in the manner of slates or shingles.

The leaf of the breadfruit is two feet in length, one and more in width, and deeply indented. It is prepared for thatching by stringing the leaves as closely as possible upon a rod of light wood, ten or twelve feet long and half an inch in diameter, through a slit made in the stem of each leaf; it is then attached to the roof and sides in the same manner as the cocoanut, and forms a more durable and better thatch.

But the palmetto affords the most valued covering, and that most used—especially for the roof—wherever found in sufficient abundance. Its fan-like leaves are fastened one by one, with their centres about a foot from each other, upon long, split pieces of the hibiscus, which are then ranged upon the roof, sixteen or eighteen inches apart, and, thus disposed, lap considerably every way, over each other. All these kinds of thatch, instead of becoming dark and sunburnt, like the grass of the Sandwich Islands huts, bleach beautifully; and when seen at a distance, gleam among the groves, in the brightness of the day, like neatly whitened cottages in our own country.

The fronts of the habitations are seldom thatched. Sometimes they are entirely open; in which case the timber supporting the roof, and the pillars beneath, are generally neatly hewn and ornamented by braids of sennit of various colors, white, black, yellow, etc., tied on in horizontal stripes, in diamonds or in checks, in a pretty and fanciful manner. In most of the houses, however, the front is composed of bamboos, lashed horizontally to the pillars, at intervals of an inch or two, or in lattice-work, for the admission of light; in which case there is a small door in the middle, furnished with a shutter, in a slide, to be closed or opened at pleasure.

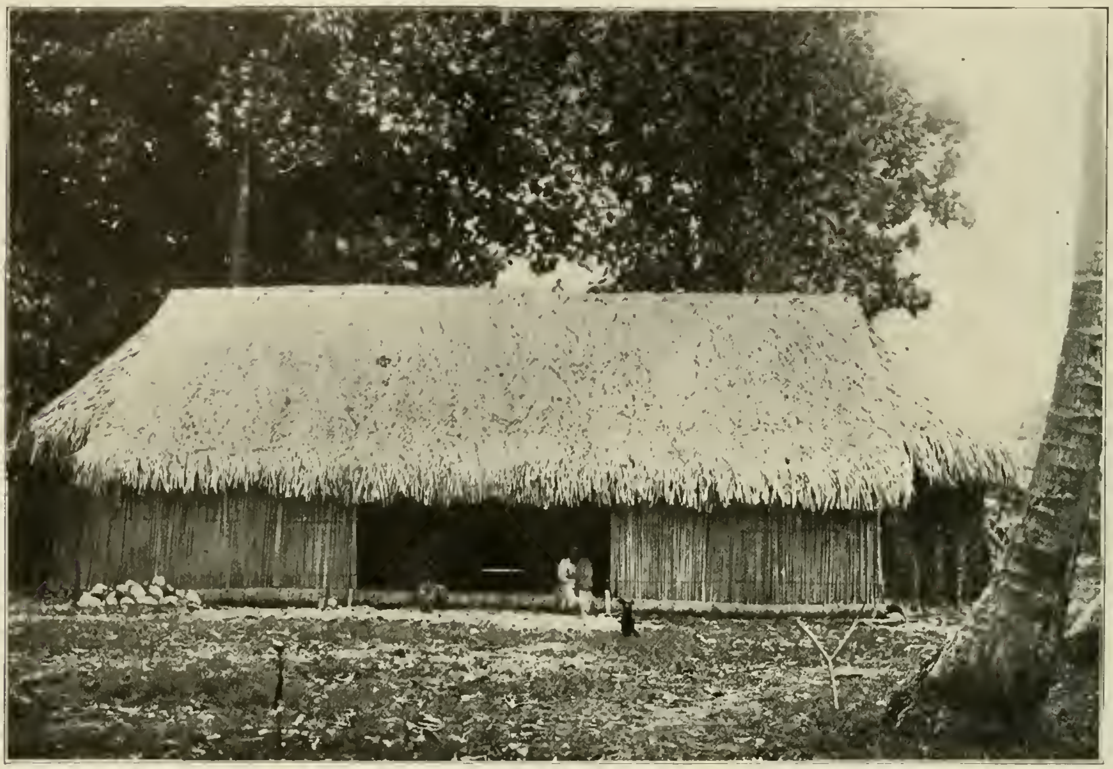


FIG. 3. TAHITIAN QUEEN'S HOUSE.

In every house the internal arrangement is the same. A smooth trunk of a cocoanut tree extends the whole length, a foot or two from the farther side. At an interval of about four feet another lies parallel to it; and the space between, spread with grass and covered with mats, constitutes the bed of the whole family and household—the innermost log forming a general pillow, and the second a support for the lower limbs, which extend over it. The rest of the area is a paved floor—a foot or two above the platform without—upon which they partake of their meals and perform their indoor work.

Calabashes of food and water—wooden bowls and trays—some stone adzes with other rude implements—numerous spears and war-clubs—and a few muskets sticking in the thatch—constituted the furniture of the establishment.[2]

---

[2] Charles S. Stewart.—A Visit to the South Seas in 1829-30. New York, 1831. I, p. 233.

Now Cook speaks of the Marquesan houses that he saw at Tahuata (Santa Cristina of his voyage) in by no means so eulogistic tone. He says:[3]

> Their dwellings are in the vallies and on the sides of the hills, near their plantations. They are built after the same manner as at Otaheite; but are much meaner, and only covered with the leaves of the bread tree. The most of them are built on a square, or oblong, pavement of stone raised some height above the level of the ground. They likewise have such pavements near their houses, on which they sit to eat and amuse themselves.

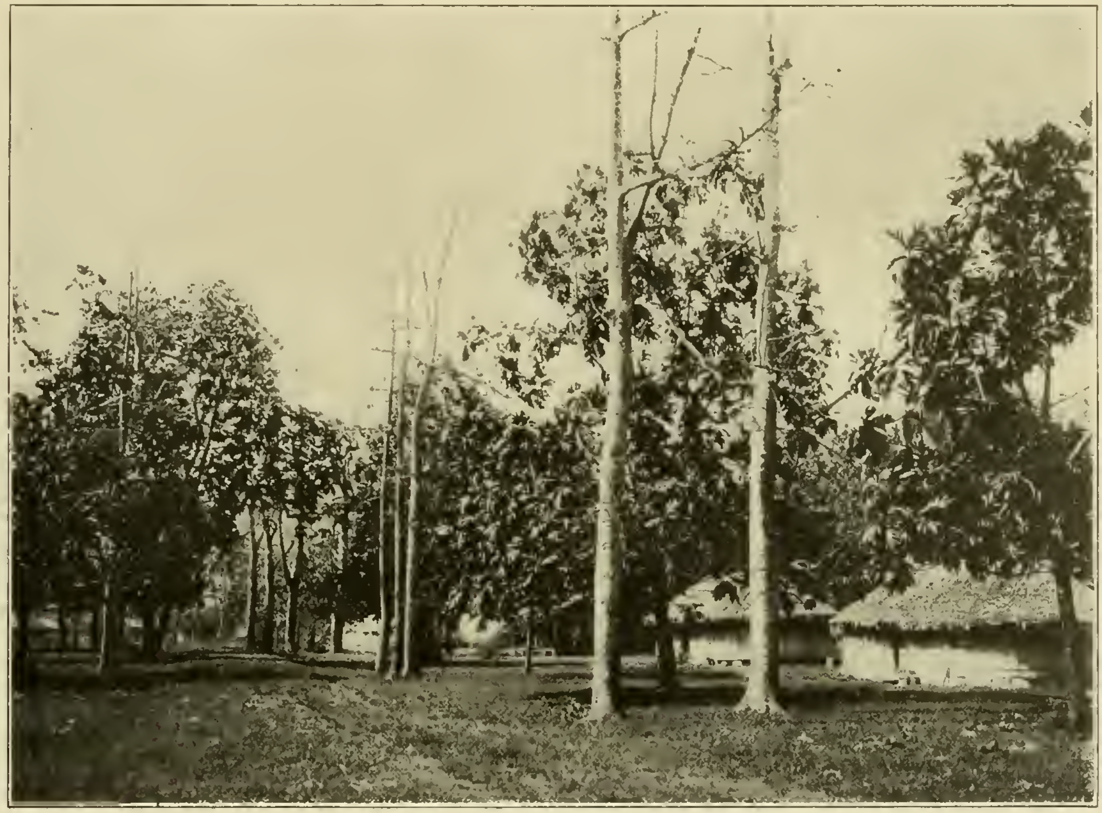


FIG. 4. TAHITIAN VILLAGE.

Not a word about the most marked peculiarity of the last description—the halved form shown in Fig. 2. The platforms are also shown in that figure. This is the more remarkable as Cook was usually quick to notice any strange thing, and this manner of building he found nowhere else in the Pacific.

Society Islands, Tahiti.—From the savage tempered and warlike Marquesan we turn to the indolent, pleasure loving Tahitian. The one a cannibal, the other loving his fellows in a different way. Cook had more time to study the Tahitians, and he certainly gives us a pleasant picture:[4]

---

[3] Cook, Second Voyage. I, p. 310.

[4] Cook, Journal (printed verbatim), July, 1769, p. 96.

The Houses or dwellings of these People are admirably calculated for the continual warmth of the Climate; they do not build them in Towns or Villages, but seperate each from the other, and always in the Woods, and are without walls, so that the air, cooled by the shade of the Trees, has free access in whatever direction it happens to blow. No country can boast of more delightful walks than this; the whole Plains where the natives reside are covered with groves of Bread Fruit and Cocoa Nut Trees, without underwood, and intersected in all directions by the Paths which go from House to House, so that nothing can be more grateful in a Climate where the sun hath so powerful an influence. They are generally built in form of an Oblong square, the Roofs are supported by 3 Rows of Pillars or Posts, and neatly covered with Thatch made of Palm leaves. A middle-siz'd house is about 24 ft. by 12, extream heigth about 8 or 9, and heigth of the Eves 3½ or 4. The floors are cover'd some inches deep with Hay, upon which, here and there, lay matts for the convenience of sitting down; few houses has more than one Stool, which is used only by the Master of the family. [See Fig. 8.]

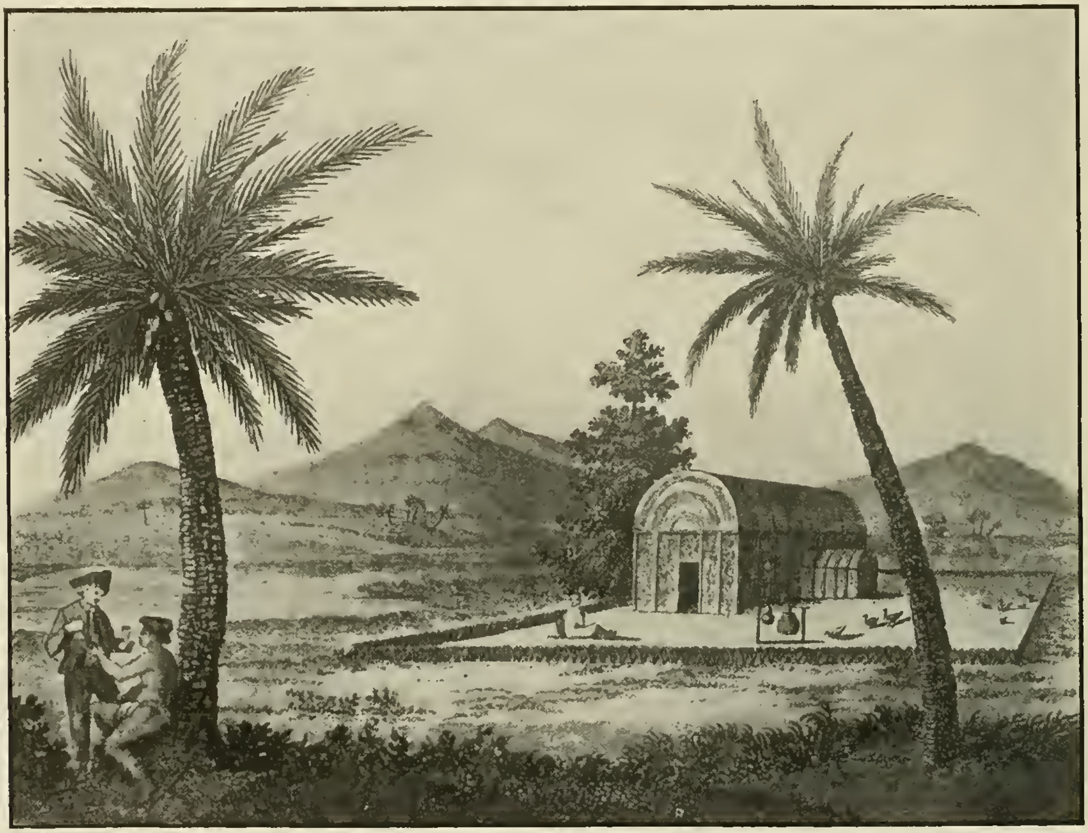


FIG. 5. TAHITIAN CHIEF'S HOUSE.[5]

In their houses are no rooms or Partitions, but they all huddle and Sleep together; yet in this they generally observe some order, the Married people laying by themselves, and the unmarried each sex by themselves, at some distance from each other. Many of the *Earcs* or Chiefs are more private, having small movable houses in which they Sleep, man and Wife, which, when they go by Water from place to place, are tied upon their canoes; these have walls made of Cocoa-Nut leaves, etc. I have said that the houses are without walls, but this is only to be understood in general, for many of them are walled with wickering but not so close but to admit a free circulation of Air. The matts which serve them to sit upon in the daytime are also their beds in the night, and the Cloathes they wear in the day serve for covering, a little wood Stool, block of wood, or bundle of Cloth for a Pillow. Besides these common houses there are others much larger, 200 feet long and upwards, 30 broad, and 20 in heigth. There are generally two or three of these in every district, and seem'd not only built for the accommodation of the principal people, but common to all the inhabitants of that district, and raised and kept up by their joint labour; these are always without walls, and have generally a large Area on one side neatly enclosed with low pallisades, etc.

---

[5] Plate VI of Parkinson's Journal.

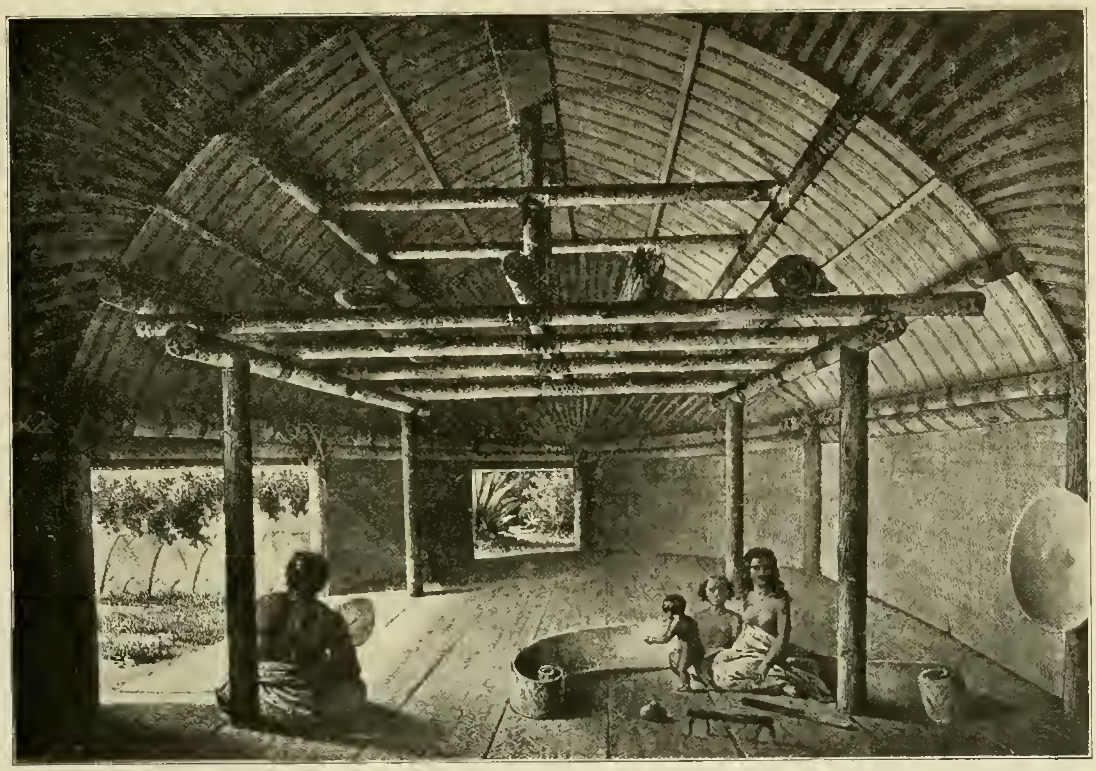


FIG. 6. TONGAN INTERIOR (VOYAGE DE L'ASTROLABE, PL. 75).

With Cook was the young artist Parkinson (who did not live to complete the voyage), and he gives us a picture of the house of a Tahitian chief which is so remarkable a deviation from Polynesian domestic architecture that, were it not for his accuracy of draughtmanship in other things, might be treated as a creature of his imagination. He gives no description but the view shows clearly the outside of a high house with a barrel-vaulted roof.[6] The framing seems to be on the outside and the thatch within. The "Area on one side" which Cook mentions is clearly shown (Fig. 5).

---

[6] Parkinson says in a note: Taotahau's house is one hundred and twenty yards long, and twenty yards broad: the roof is supported by twenty posts each nineteen feet high." Parkinson's Journal, p. 55.

Tongan Houses.—Abel Tasman, the discoverer of the Tongan Group which the next visitor, Cook, called Friendly Islands, gives us no description of the houses on this cluster of comparatively low islands, and we must look to Cook for the needed information. Now the Tongans are peculiarly situated, for while the racial affinities are all with the Tahitians, their commercial dealings were chiefly with the Fijians, a race usually considered a cross between the Polynesian and some darker strain, whether Melanesian or Papuan. Hence it is interesting to find what we can of their dwellings. We must begin with Cook. Speaking of the houses on Namuka he says:[7]

> Some here differ from those I saw at the other isles; being inclosed or walled on every side with reeds neatly put together but not close. The entrance is by a square hole about two and a half feet each way. The form of these houses is an oblong square; the floor or foundation every way shorter than the eve, which is about four feet from the ground. By this construction, the rain that falls on the roof, is carried off from the wall; which otherwise would decay and rot.

On his third and last voyage (1784) Cook again saw the Tongan group and he gives us his final impressions. Probably with his seamanship he disapproved of so many bare spars in the interior of the Tongan house, although he admits they are judiciously arranged:[8]

> It is remarkable that these people, who, in many things, shew much taste and ingenuity, should shew little of either in building their houses; though the defect is rather in the design, than in the execution. Those of the lower people are poor huts, scarcely sufficient to defend them from the weather, and very small. Those of the better sort are larger and more comfortable; but not what we might expect. The dimensions of one of a middling size, are about thirty feet long, twenty broad, and twelve high. Their house is, properly speaking, a thatched roof or shed, supported by posts and rafters, disposed in a very judicious manner. The floor is raised with earth smoothed, and covered with strong, thick matting, and kept very clean. The most of them are closed on the weather side (and sometimes more than two thirds round), with strong mats, or with branches of the cocoanut tree, plaited or woven with each other. These they fix up edgewise, reaching from the eaves to the ground; and thus they answer the purpose of a wall. A thick strong mat, about two and one half or three feet broad, bent into the form of a semicircle, and set upon its edge, with the ends touching the side of the house, in shape resembling the fender of a fire hearth, incloses a space for the master and mistress of the family to sleep in. * * * * * The rest of the family sleep upon the floor, wherever they please to lie down, the unmarried men and women apart from each other. Or, if the family be large, there are small huts adjoining, to which the servants retire in the night: so that privacy is as much observed here, as one could expect. They have mats made on purpose for sleeping on; and the clothes that they wear in the day, serve for their covering in the night. Their whole furniture consists of a bowl or two, in which they make *kava;* a few gourds; cocoa-nut shells; some small wooden stools, which serve them for pillows; and perhaps a large stool for the Chief or Master, of the family to set upon. (Fig. 8.)

Cook's description is illustrated indirectly by a drawing representing the ceremonious Awa Drinking, which is here reproduced, as it shows well the judicious arrangement of the supporting beams of which the great navigator speaks.

---

[7] Cook's Second Voyage. II, p. 21.

[8] Cook's Third Voyage, 1784. I, p. 393.

Next comes the account of William Mariner, a man whose name is honored as that of an accurate observer by all who study the Eastern Pacific. His compulsory residence of several years on the group has given us perhaps the best account of the daily life of that early time that we have.[9] Of Tongan housebuilding his words are few but to the point and may be quoted in full:

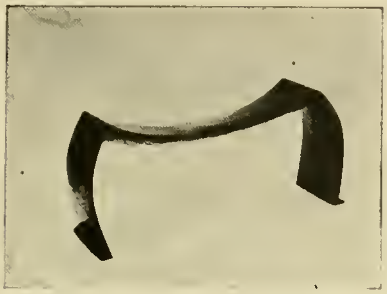


FIG. 7. TONGAN PILLOW.

> *Laga fale*, house-building. Every man knows how to build a house, but those whose business it is have chiefly to erect large houses on marly's, consecrated houses, and dwellings for chiefs. The general form of their houses is oblong, rather approaching to an oval, the two ends being closed, and the front and back open; the sloping thatched roof descending to within about four feet of the ground, which is generally supported by four posts; the larger houses by six, or sometimes more. The chief art in building a house consists in fastening the beams, &c., strongly, with plait of different colours, made of the husk of the cocoa-nut, in such a way as to look very ornamental; the colours, which are black, red and yellow, being tastefully disposed. The thatch of the superior houses is made of the dried leaves of the sugar cane, and which will last seven or eight years without requiring repair. The thatch of the common houses is made of matting formed of the leaves of the cocoa-nut tree, and which lasts about two or three years; but being much easier to make than the other, it ismore frequently used. The flooring is thus made: the ground, being raised about a foot, is beaten down hard, and covered with the leaves of the cocoa-nut tree, dried grass, or leaves of the ifi tree (*Inocarpus edulis*): over this is laid a bleached matting, made of the young leaves of the cocoanut tree. The house consists, as it were, but of one apartment, but which is subdivided occasionally by screens about six or eight feet high. In case of rain, or at night, if the weather is cool, they let down a sort of blind,

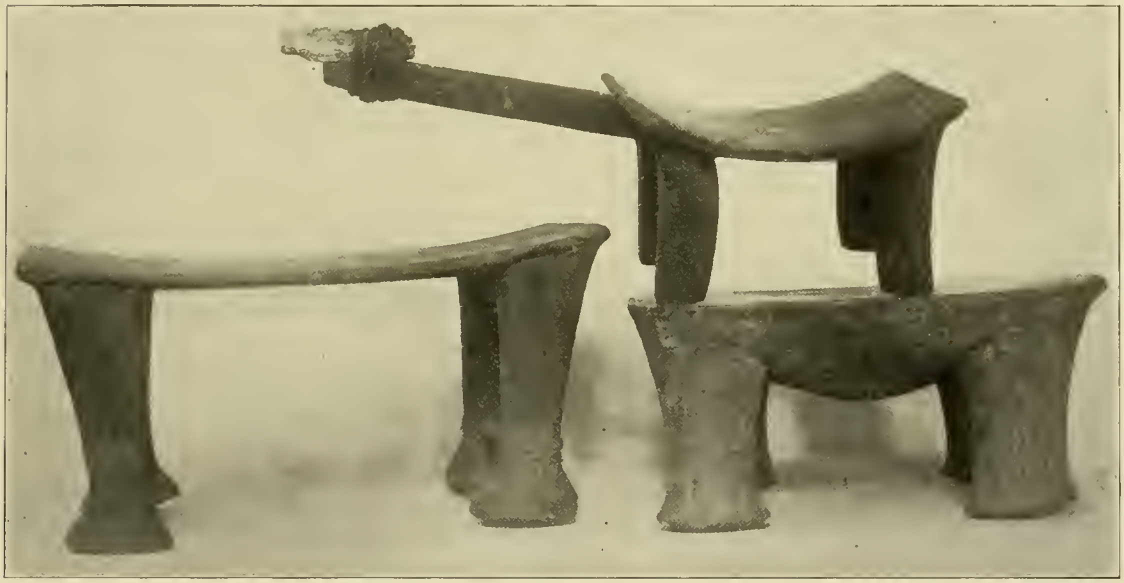


FIG. 8. WOODEN STOOLS.

---

[9] An Account of the Natives of the Tonga Islands. Compiled and arranged from the extensive communications of Mr. William Mariner by John Martin, M.D. London, 1817. II, p. 279.

which is attached to the eaves of the open sides of the house: these blinds are made of long mats, about six inches in width, one above another, and rather overlapping, and are so contrived as to draw up by means of strings, like our Venetian blinds, and are then concealed just within the eaves. The common houses have not these blinds, but, in place of them a few mats hung up as occasion may require.

Half a century passed and we have another record of the Tongan house from a resident of some years, and this seems to fill the few lines undrawn in the former pictures. Even with the example set by King George Tubou, who delighted to build his numerous residences of foreign material in foreign manner, the general character of the Tongan house remained the same as when Cook and Mariner described it. I quote from the interesting account of the Reverend Thomas West:[10]

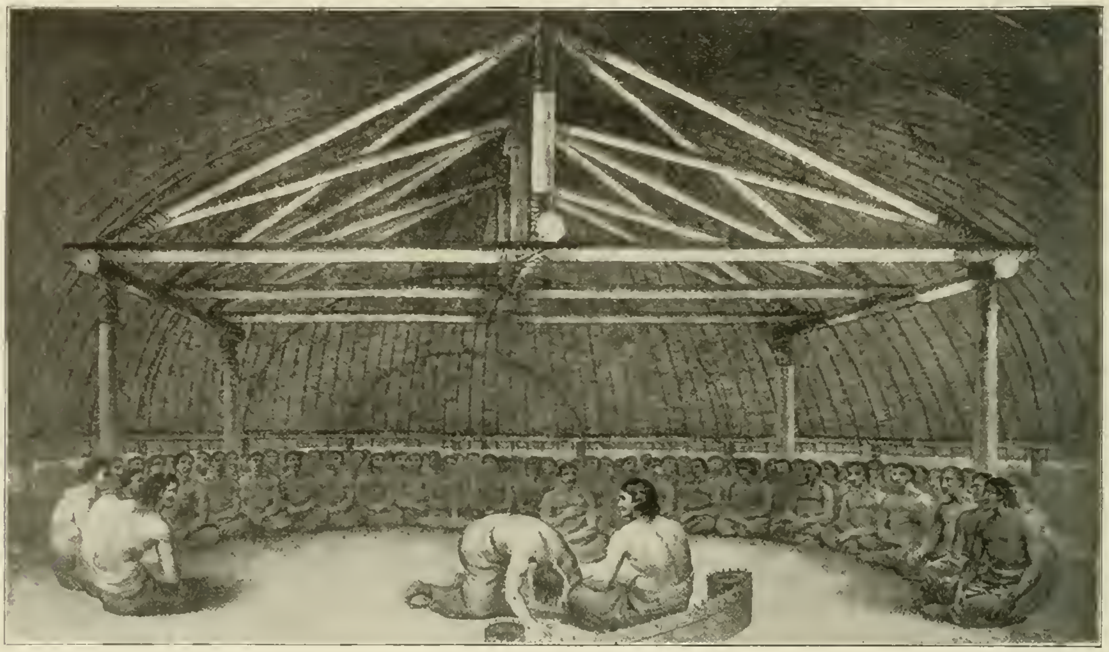


FIG. 9. KAVA DRINKING IN TONGA (PL. 20 OF COOK'S THIRD VOYAGE).

> Nukualofa (the Capital) is intersected by tolerably wide paths, kept scrupulously free from all rank vegetation and dirt. These paths are bounded by the neat reed fences which enclose the *abis* or residential sections of the various chiefs and their retainers. These enclosures are planted largely with useful trees, such as the bread-fruit, banana, cocoa-nut, orange, citron, shaddock, and a variety of shrubs whose overhanging foliage effectually screens the pathways from the intense heat of the sun. Very little order is observed in placing the numerous houses within these enclosures. There are no regular avenues or streets. In fact a house is generally placed where it can obtain the greatest amount of shade from overhanging trees,—a matter certainly of considerable importance in a tropical climate. A casual visitor, therefore, can see but few dwellings even when he has entered within the *toto a*, or fence of the *abi;* and, until he hunts them out amongst the abounding shrubbery, he wonders where the people live.

---

[10] Ten years in South-Central Polynesia: Being reminiscences of a personal mission to the Friendly Islands and their Dependencies. London, 1865, p. 44.

A Tonguese house suits the few necessities and easy habits of the people, but has none of the comforts so essential to a higher type of civilization. With the exception of what may be called public buildings, and a few of the dwellings of the chiefs of highest rank, their dimensions are small, and they contain but two apartments. They are, however, constructed with an eye to neatness and great strength; and when elaborately finished in the best native style, their interior appearance is by no means to be despised. The walls range from four to eight feet in height, and are formed either of a single or double fencing of reeds, which, when interlaced and bound by sinnet to the *tokotuus*, or stakes and posts, planted all round the eaves of the building, resembles very much strong basket-work. These walls are sometimes made more wind and weather tight by the addition of a lining of plaited cocoa-nut leaves; but, at the best, they afford a sorry resistance to strong winds or heavy rains. On the other hand, there is capital ventilation; and perhaps that is of greater importance in such a hot climate, than even freedom from the more occasional annoyances attendant upon stormy weather. To compensate for the lowness of the walls, the roof of a Tonguese house is carried to a considerable height. The rafters are closely set, and are generally made of the outer wood of the cocoa-nut tree, or of the breadfruit tree, the latter of which has much the appearance of cedar wood; and has a very pleasing and beautiful effect when nicely finished. The large beams to which the rafters are attached, are laid along the grooved tops of high and durable posts, which reach about half way up the entire height of roof. The inner ridgepole is usually ornamented by a profusion of sinnet wrappings of varied colors and geometrically interlaced. The roof itself is covered with a thick thatch, made from the leaves of the sugar cane or of the bamboo, and is perfectly water-tight. A well-built house will last a good many years; but the thatching requires to be renewed, under the most favourable circumstances, about once in five years. The floor is laid with a profusion of dried leaves, which are in turn covered over with numbers of mats made from the cocoa-nut leaf, upon which again the finer sitting and sleeping mats are placed. No provision is made in the interior of either native or European house for cooking conveniences. A separate building contains the kitchen requisites, and the heat of the climate renders a fire-place in the dwelling house unnecessary. What is wanting in the architectural beauty of these houses is amply remedied by the loveliness of the natural bowers, from which they peep out upon the passer-by.

With all this detail of the outward appearance not a word of the method of erecting the house. We learn, however, that there has been little or no change from the time of Cook. The marked feature is the open nature of the structure, which was evidently used for something more than a shelter from rain and a bedroom. Turning from Tonga to Samoa we find the same open structure and ground plan, although the Samoans had by no means the close connection with the Tongans that the Fijians had: we shall see later that the latter built a very different house.

Samoan Houses.—In several visits to the Samoan Islands, both at Apia on the island of Upolu and at Pagopago on the island of Tutuila I have visited native houses and to some extent examined their structure; I have been seated on the low fence that is a part of the house structure and serves to keep out pigs and other four-footed unwelcome visitors, and discussed with the hospitable inmates matters relating both to the house and to its furniture, but as the evidence of foreign improvements was incontrovertible (kerosene lamps, crockery, boards, etc.) I prefer to turn to a trustworthy authority on Samoan houses as on other matters relating to that group half a century ago when the change from ancient to modern was not so perceptible. The Rev. Geo. Turner has recorded[11] for us the following account of the Samoan houses:

> Imagine a gigantic beehive, thirty feet in diameter, a hundred in circumference, and raised from the ground about four feet by a number of short posts, at intervals of four feet from each other all round, and you have a good idea of the appearance of a Samoan house.[12] The spaces between these posts, which may be called open doors or windows, all round the house, are shut in at night [or during stormy weather] by roughly plaited cocoa-nut leaf blinds. During the day the blinds are pulled up, and all the interior exposed to a free current of air. The floor is raised six or eight inches with rough stones; then an upper layer of smooth pebbles; then some cocoa-nut-leaf mats, and then a layer of finer matting. Houses of important chiefs are erected on a raised platform of stone three feet high. In the centre of the house there are two, and sometimes three, posts or pillars, twenty feet long, sunk three feet into the ground, and extending to and supporting the ridge pole. These are the main props of the building. The space between the rafters is filled with what they call *ribs*, viz., the wood of the bread-fruit tree, split up into small pieces, and joined together so as to form a long rod the thickness of the finger, running from the ridge pole down to the eaves. All are kept in their places, an inch and a half apart, by cross pieces, made fast with cinnet. The whole of this upper cagelike work looks compact and tidy, and at the first glance is admired by strangers as being alike novel, ingenious and neat. The wood of the bread-fruit tree, of which the greater part of the best houses are built, is durable, and, if preserved from wet, will last fifty years.

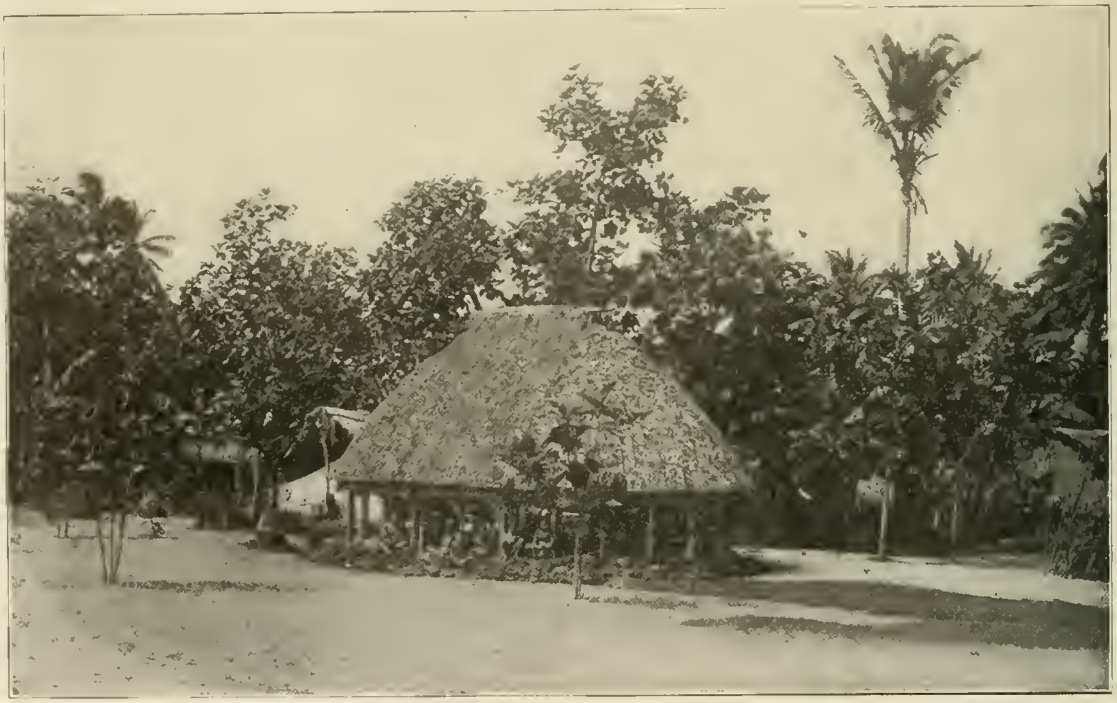


FIG. 10. SAMOAN HOUSE.

---

[11] Nineteen Years in Polynesia: Missionary Life, Travels, and Researches in the Islands of the Pacific. London, 1861, p. 256.

[12] It should be noted that the ground plan is elliptical, not circular, as might be inferred from this description.

The thatch, also, is laid on with great care and taste; the long dry leaves of the sugar-cane are strung on to pieces of reed five feet long; they are made fast to the reed by overlapping the one end of the leaf, and pinning it with the rib of the cocoa-nut leaflet, run through from leaf to leaf horizontally. These reeds, thus fringed with the sugar-cane leaves hanging down three or four feet, are laid on, beginning at the eaves and running up to the ridge pole, each one overlapping its fellow an inch or so, and made fast one by one with cinnet to the inside rods or rafters. Upwards of a hundred of these reeds of thatch will be required for a single row running from the eaves to the ridge pole; then they do another row, and so on all round the house. Two, three, or four thousand of these fringed reeds may be required for a good sized house. This thatching if well done will last for seven years. To collect the sugar-cane leaves, and "sew", as it is called, the ends on to the reeds, is the work of the women. An active woman will sew fifty rods in a day, and three men will put up and fasten on to the roof of the house some five hundred in a day. For coolness and ventilation nothing beats the thatch. The great drawback is, that in gales it stands up like a field of corn, and then the rain pours into the house. That, however, may be remedied by a network of cinnet, to keep down the thatch, or by the native plan of covering all in with a layer of heavy cocoa-nut leaves on the approach of a gale.

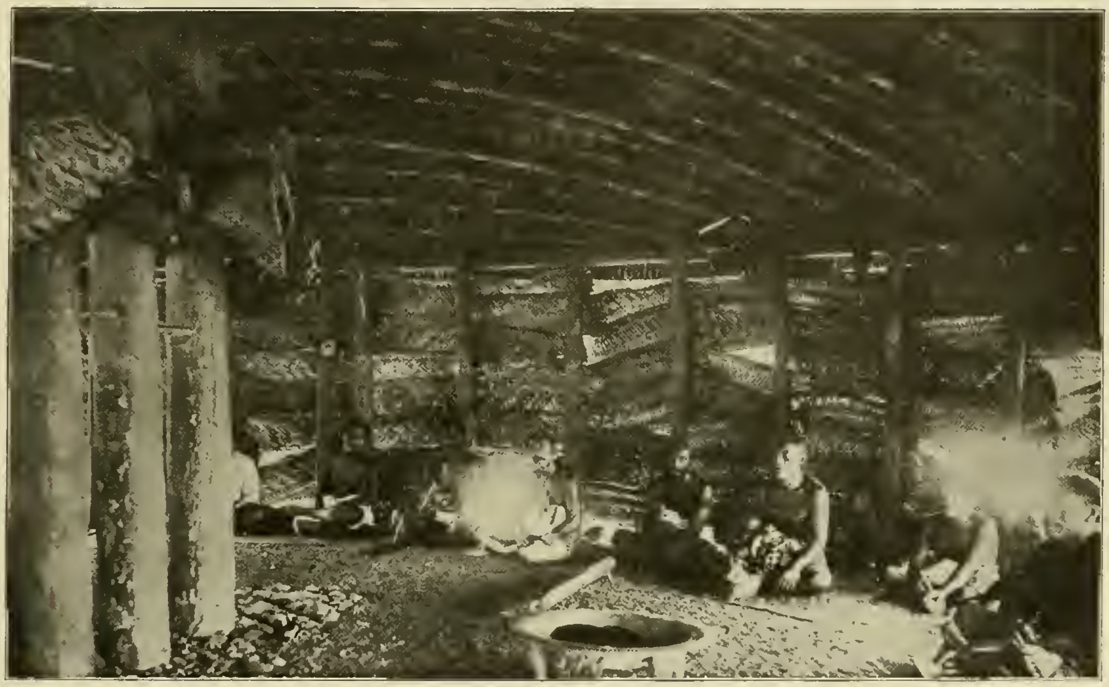


FIG. 11. SAMOAN INTERIOR.

These great circular roofs are so constructed that they can be lifted bodily off the posts, and removed anywhere, either by hand, or by a raft of canoes. But in removing a house, they generally divide the roof into four parts, viz., the two sides, and the two ends, where there are particular joints left by the carpenters, which can easily be untied, and again fastened. There is not a single nail in the whole building; all is made fast with cinnet. The arrangement of the houses in a village has no regard whatever to order. You rarely see three houses in a line. Every one puts his house on his little plot of ground just as the shade of the trees, the direction of the wind, the height of the ground, etc., may suit his fancy.

A house, after the usual Samoan fashion, has but *one* apartment. It is the common parlour, dining-room, etc., by day, and the bed-room of the whole family by night. They do not, however, altogether herd indiscriminately. If you peep into a Samoan house at midnight, you will see five or six low oblong *tents* [*tainamu*] pitched (or rather strung up) here and there through the house. They are made of native cloth,[13] five feet high, and close all round down to the mat. They shut out the mosquitoes, and inclose a place some eight feet by five; and these said tent-looking places may be called the *bed-rooms* of the family. Four or five mats laid loosely, the one on the top of the other, form the *bed;* the pillow is a piece of thick bamboo, three inches in diameter, three to five feet long, and raised three inches from the mat by short wooden feet (Fig. 13). After private prayer in the morning, the tent is unstrung, mats, pillow and sheet rolled together, and laid up overhead on a shelf between the posts in the middle of the house.

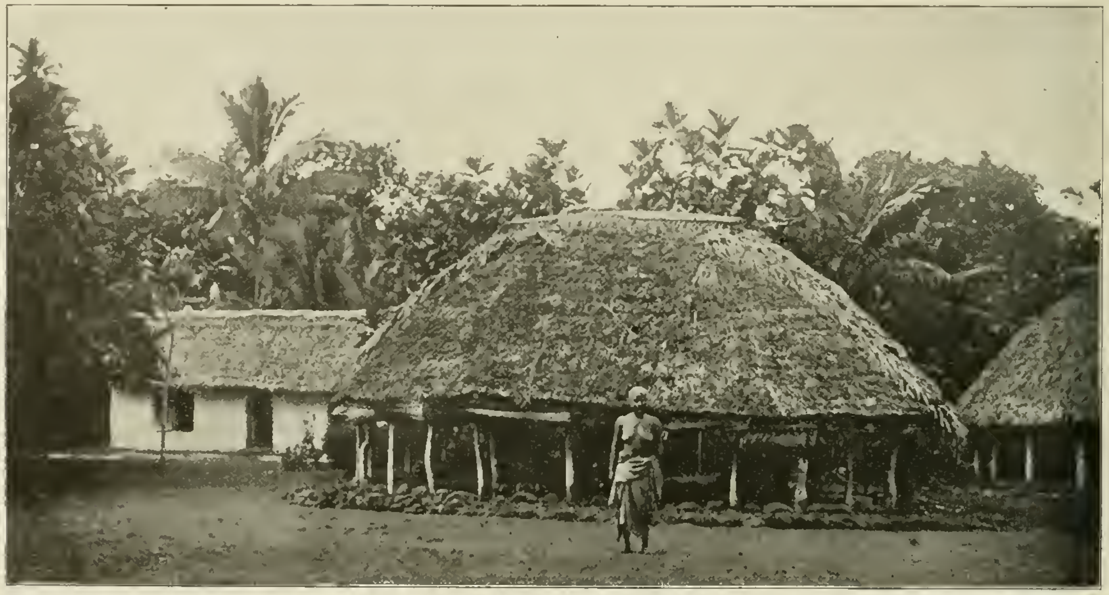


FIG. 12. SAMOAN PALACE.

These rolls of mats and bedding, a bundle or two done up in native cloth, on the same shelf in the centre of the house, a basket, a fan or two, and a butcher's knife stuck into the thatch within reach, a fishing net, a gun strung up along the rafters, a few paddles, a wooden chest in one corner, and a few cocoa-nut shell water-bottles in another, are about all the things in the shape of furniture or property you can see in looking into a Samoan house. The fireplace is about the middle of the house. It is merely a circular hollow, two or three feet in diameter, a few inches deep, and lined with hardened clay. It is not used for cooking, but for the purpose of lighting up the house at night. A *flaming fire*, was the regular evening offering to the gods, as the family bowed the head, and the fathers prayed for prosperity from the "gods great and small". The women collect, during the day, a supply of dried cocoa-nut leaves, etc., which, with a little management, keep up a continued blaze in the evening, while the assembled family group have their supper and prayer and sit together chatting for an hour or two afterwards.

But about *house-building:* it is a distinct trade in Samoa; and perhaps, on an average, you may find one among every three hundred men who is a master carpenter. Whenever this person goes to work, he has in his train some ten or twelve, who follow him, some as journeymen, who expect payment from him, and others as apprentices, who are principally anxious to learn the trade. If a person wishes a house built, he goes with a fine mat, worth in cash value 20s. or 30s. He tells the carpenter what he wants, and presents him with the mat as a pledge that he shall be well paid for his work. If he accept the mat, that also is a pledge that he will undertake the job. Nothing is stipulated as to the cost; that is left entirely to the honor of the employing party. At an appointed time the carpenter comes with his staff of helpers and learners. Their only tools are a felling-axe, a hatchet, and a small adze; and there they sit, chop, chop, chopping, for three, six, or nine months, it may be, until the house is finished. Of old they used stone and shell adzes.

---

[13] Siapo or kapa beaten loosely, but still too tight to be endurable for a white man. One in the Bishop Museum No. 2231, is heavily varnished with breadfruit gum.

The man whose house is being built provides the carpenters with board and lodging, and is also at hand with his neighbors to help in bringing wood from the bush, scaffolding, and other heavy work. It is a lasting disgrace to any one to have it said that he paid his carpenter shabbily. It brands him as a person of no rank or respectability, and is disreputable, not merely to himself, but to the whole family or *clan* with which he is connected. The entire tribe or clan is his *bank*. Being connected with that particular tribe, either by birth or marriage, gives him a latent interest in all their property, and entitles him to go freely to any of his friends to ask for help in paying his housebuilder. He will get a mat from one, worth twenty shillings; from another he may get one more valuable still; from another, some native cloth worth five shillings; from another four or six yards of calico; and thus he may collect, with but little trouble, two or three hundred useful articles, worth, perhaps, forty or fifty pounds; and in this way the carpenter is generally well paid. Now and then there will be a stingy exception; but the carpenter, from certain indications, generally sees ahead, and decamps with all his party, leaving the house unfinished. It is a standing custom, that after the sides and one end are finished, the principal part of the payment be made; and it is at this time that a carpenter, if he is dissatisfied, will get up and walk off. A house with two sides and but one end, and the carpenters away, is indicative. Nor can the chief to whom the house belongs employ another party to finish it. It is a fixed rule of the trade, and rigidly adhered to, that no one will take up the work which another party has thrown down. The chief, therefore has no alternative but to go and make up matters with the original carpenter, in order to have his house decently completed. When a house is finished, and all ready for occupation, they have their "house-warming" or, as they call it, its *oven consecration;* and formerly it was the custom to add on to that a dance, for the purpose of "treading down the beetles."

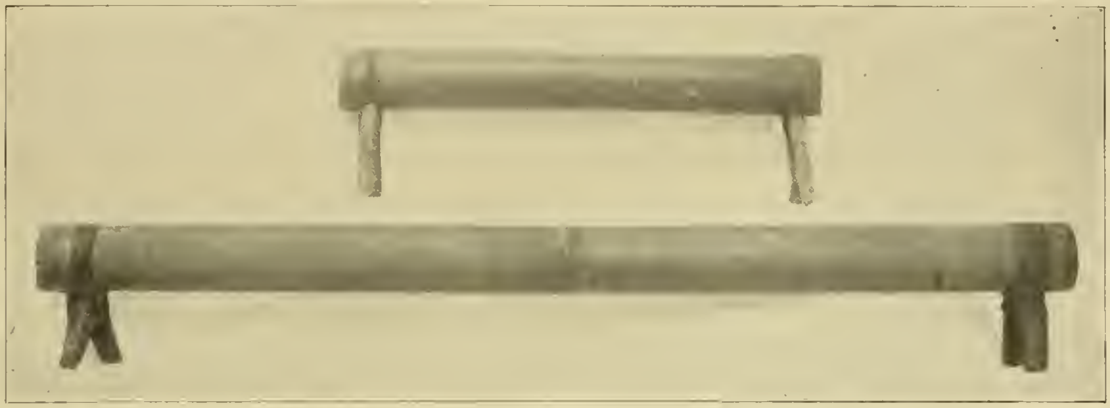


FIG. 13. SAMOAN ALI OR PILLOW OF BAMBU.

Samoan temples (*Fale-aitu*=Spirit house) were built in the same manner as ordinary houses, according to the Rev. J. B. Stair;[14] but in the picture he gives of these structures (Fig. 15) they seem to be round rather than oval. The *fanua-tanu* or raised platform was high in proportion to the respect intended to be shown to the deity to whom the temple was dedicated, or perhaps to the means of the builder. In most cases if it was a family fane all the family were expected to help build it; if a public one all the village turned out and worked.

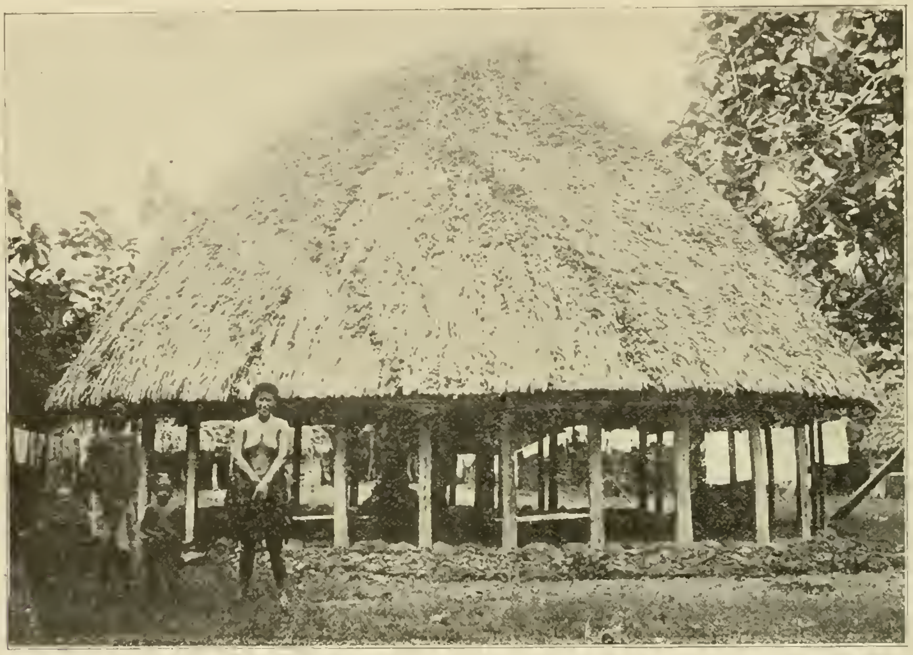


FIG. 14. SAMOAN HOUSE.

It must not be supposed that this temple was what is generally understood by the term, a place in which to worship. A tree might be chosen as the temporary abode of the *aitu* [Hawaiian *akua*], or indeed any secluded place, but the *fale aitu* was usually in the midst of a village and was surrounded by a low fence or hedge. The priests entered these houses, when consulted by the people, to inquire of the god who was supposed to be for the time immanent in the priest and to use his voice for the desired answer. It was then a sort of oracle by which the priest doubtless profited, whether the consultant was satisfied or mystified. The Reverend author goes on to describe a ruin that may throw a side light on the Tongan trilithon. We shall see that the circular plan appears again in New Caledonia. He writes (p. 228):

---

[14] Old Samoa, by Rev. J. B. Stair, p. 226. London, 1897.

One very interesting exception to the usual style of building these temples is found in the case of a remarkable old ruin of the *Fale-o-le-Fe'e* (House of the Fe'e), the famous war-god of A'ana and Faleata, the site of which became known to me a short time before leaving Samoa in 1845. This appears to have been built in the usual Samoan style, but its ruins disclose the fact that its builders had used stone slabs for the supporting-posts of the roof, and that it got the name of *O-le-fale-ma'a-o-le-Fe'e* (the stone house of the Fe'e), and hence became enshrouded with much mystery and wonder. I think this is the only instance of such a departure from the usual style of Samoan building known in the islands.

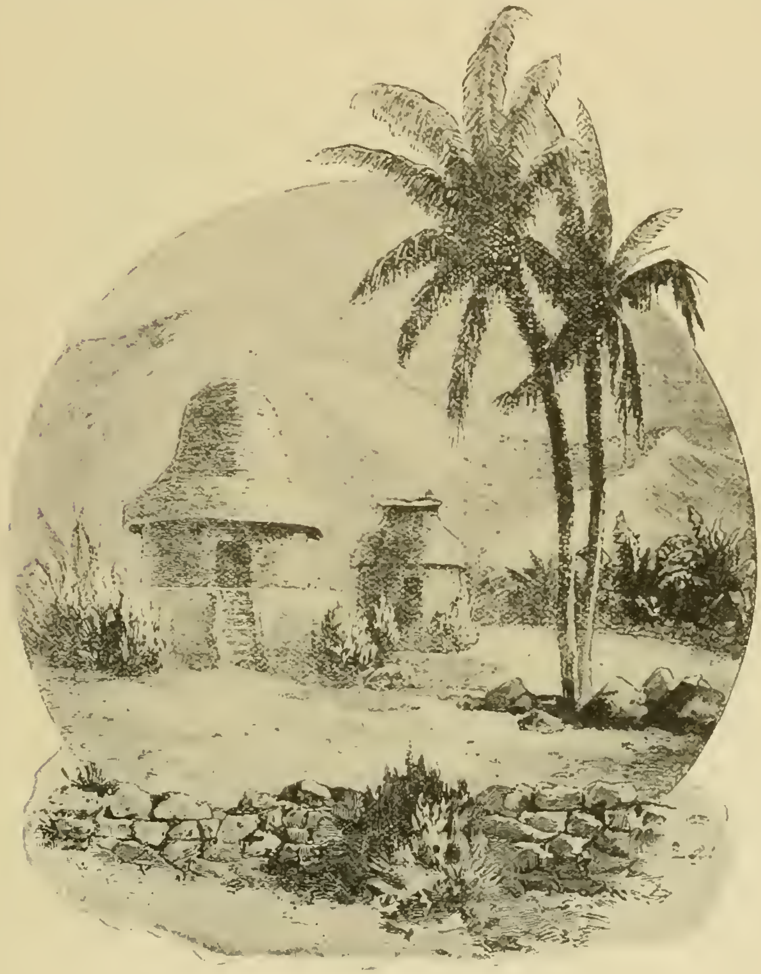


FIG. 15. SAMOAN TEMPLES (FROM STAIR).

It is unfortunate that we have no definite information of the buildings or their ruins in the Manua portion of Samoa which is supposed to be the cradle of the present Samoan population; the island Tau is still noted for its canoe builders.

Fijian Houses. — So far we have had Polynesian housebuilding, and it may seem strange to break the order by omitting the most elaborate form, that of the Maori, for the present, and taking up the work of an entirely different people as the Pacific islanders are generally classified, but my reason is not only founded on the geographical relation of the Vitian group to those whose housebuilding has already been described, but on the close relationship of form and manner of building, which as we shall see later on, nearly resembles that of the Hawaiians.

It is perhaps unnecessary to go farther back than the time of the United States Exploring Expedition (1840), for foreign influence had made little, if any, change in the manner of building dwellings, although the advance of missionary work was soon to destroy the Fijian temples. The account of the houses as given by Captain Wilkes in his Narrative[15] is rather fragmentary, probably made up from the journals of the various officers, but it gives a definite picture of the Fijian habitation as it was, and as it is in many parts of the great Vitian archipelago, parts of which if turned from cannibalism, are otherwise as they were when white men first visited the group. Captain Hudson, the second in command, and who will also be remembered as the commander of the Niagara in the laying of the first Atlantic cable, had been sent to amuse the king at Rewa with fireworks, and in the rainy weather he proceeded at once to the king's house, which is thus described:

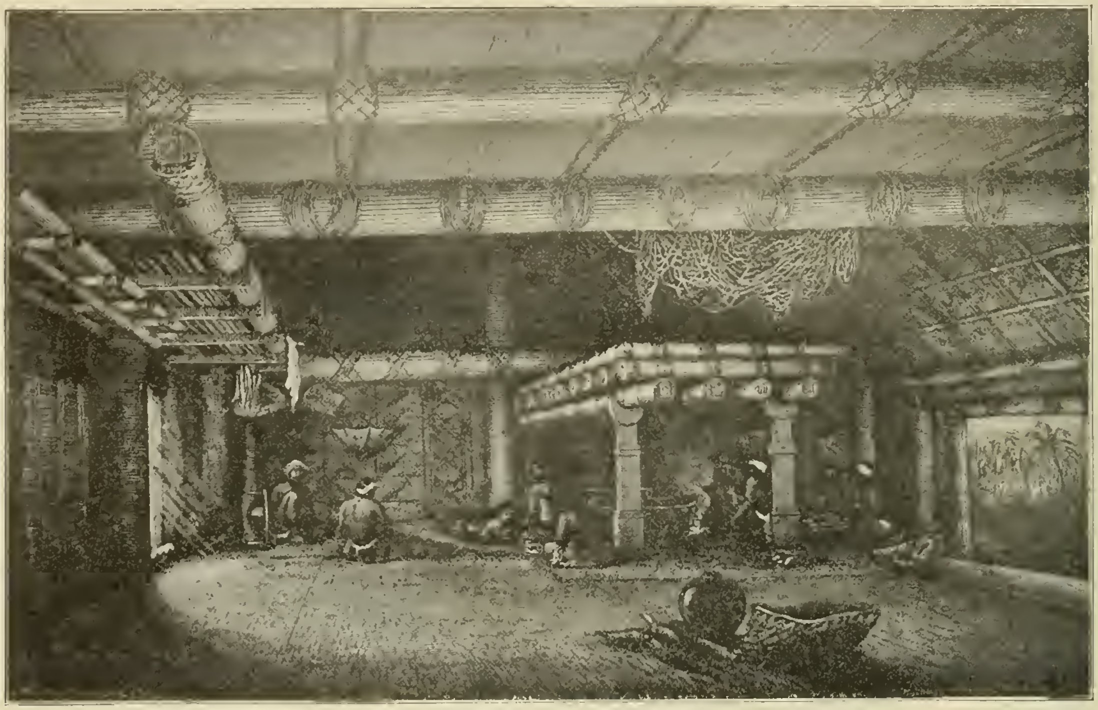


FIG. 16. INTERIOR OF NGARANINGIOU'S HOUSE, REWA (BY A. T. AGATE).

> The house is large, and in shape not unlike a Dutch barn: it is sixty feet in length and thirty in width; the eaves were six feet from the ground, and along each side there were three large posts, two feet in diameter and six feet high, set firmly into the ground; on these were laid the horizontal beams and plates to receive the lower ends of the rafters; the rafters rise to a ridge-pole thirty feet from the ground, which is supported by three posts in the centre of the building. They were of uniform size, about three inches in diameter and eighteen inches apart. The usual thick thatch was in this case very neatly made. The sides of the house were of small upright reeds, set closely together. All the fastenings were of sennit, made from the husk of the cocoa-nut. Some attempts at ornament were observed, the door-posts being covered with reeds wound around with sennit which

---

[15] Narrative of the United States Exploring Expedition, during the years 1838–1842, by Charles Wilkes, U. S. N., vol. iii, p. 113 (edition of 1845).

had a pretty effect. There are two doorways, one on each side; these are only about three feet in height, and are closed by hanging mats. * * * * * * On one side of the house, as is usual among the Feejeeans, the cooking place is excavated, a foot deep and about eight feet square; this was furnished with three large earthen pots of native manufacture.

Of a *mbure* (sacred or memorial house) they say:

The mound on which it is built is an artificial one, ten feet high: The mbure is about twelve feet square, and its sides or walls only four feet high; while its high pitched roof rises to the height of about thirty feet. The walls and roof of the mbure are constructed of canes about the size of a finger, and each one is wound round with sennit as thick as a cod line, made from the cocoa-nut husk. At a little distance, the whole house looked as though it was built of braided cord.

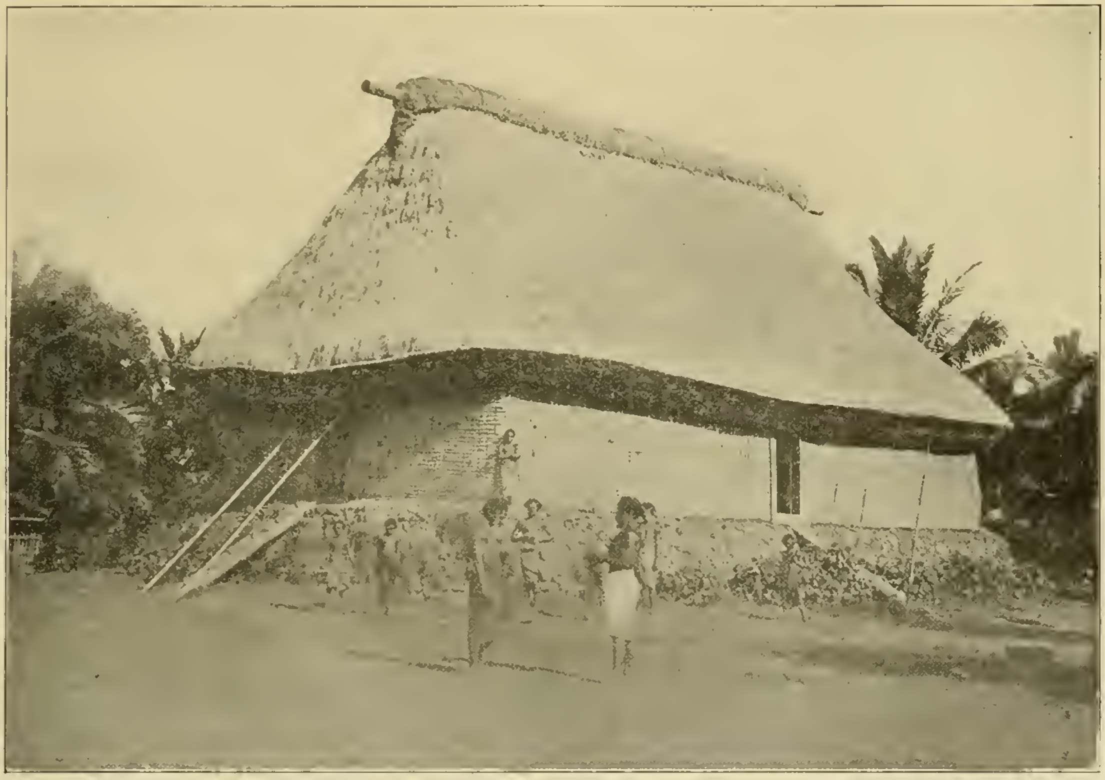


FIG. 17. FIJIAN HOUSE OF MODERN TIMES.

Again, on page 343, this general description is given:

Their houses differ from those of the other groups, although they are constructed of similar materials. The frame and sills are made of the cocoa-nut and tree fern, they have two doorways, on opposite sides, from three to four feet high, and four feet wide; the posts are set in the ground and are placed about three feet apart; the rafters of the palm tree are set upon a plate resting on the post; these have a very steep pitch, and support a cocoa-nut log, that forms the peak of the roof; the ends of the peak extend beyond the thatching at each end, and are covered with shells (*Ovulum ovum*). The thatching is peculiar being thickest at the eaves. To make the roof they begin at the peak,[16] whence they thatch down with the wild sugar-cane, under which they place fern leaves. These gradually increase in quantity until they reach to the eaves, which are about two or three feet thick, project some distance over the sides and are cut off square.

The sides are closed in with small cane, in square wickerwork, and not in diamond shape, as those of Tonga. Mats are hung before the doors. The common houses are oblong, from twenty to thirty feet in length, and fifteen feet high. Some of the best class of buildings, belonging to the chiefs, are exceedingly well and ingeniously built. If a person wishes to build a house, he carries a present of a whale's tooth to the king or chief, and tells him his wish, the size, &c. The king or chief orders the men who are generally employed for such purposes, to prepare the timber and get all things ready. The direction is given to some one as the chief superintendent, and from one to five hundred men are employed, as may be deemed necessary. The house is finished in ten or fifteen days, and will last about five years without repairs to its thatching. They are, however, generally considered tenantable for twenty years, or upwards. All the houses have fire-places a little on one side of the centre; these are nothing more than an ash-pit, with a few large stones to build the fire and place the pots on. The same kind of fire-place is to be found in the mbures, where a fire is kept burning night and day, which they believe the *kalou* or spirit requires. The houses generally are not divided by partitions, but at each end they are raised about a foot above the centre floor. These elevations are for sleeping, and are covered with layers of mats until they are soft and pleasant to lie on. In sleeping they use a pillow made of a piece of bamboo or other species of wood, about two inches in diameter, with four legs; this is placed immediately under the neck, and is sufficiently high to protect their large head of hair from being disarranged.

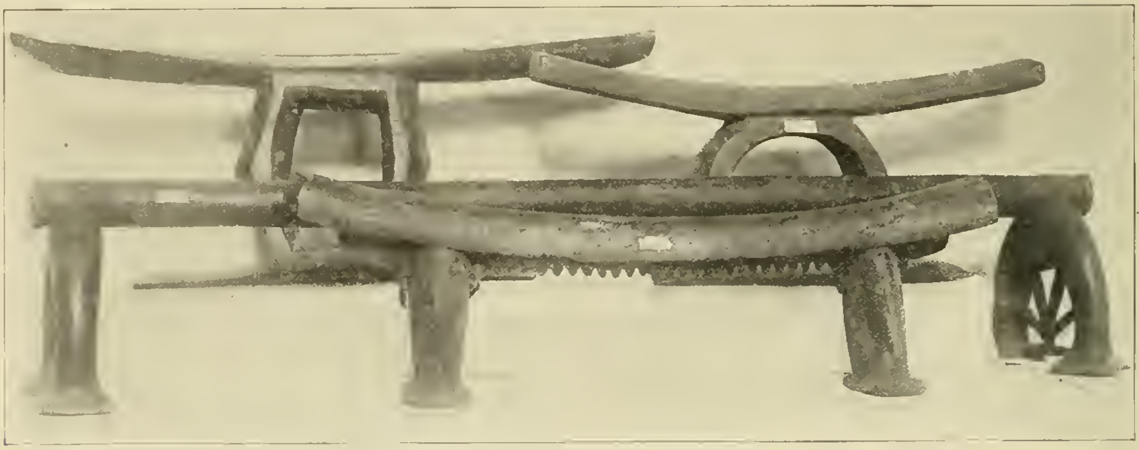


FIG. 18. FIJIAN PILLOWS IN THE BISHOP MUSEUM.

From the constant use of this pillow, a scirrhous lump, as large as a goose-egg, is often formed on the nape of the neck. This pillow was undoubtedly brought into use to protect their peculiar fashion of wearing their hair; and from the inquiries made, I found it had been used from time immemorial. Many of these pillows are carved and ornamented, and a chief always travels with his own.

Again we must turn to a devoted missionary who has lived among the Fijians and has used his eyes to good advantage. Wilkes was perhaps abreast of his times in way of gathering information, and he had the help of scientific men of undoubted ability, but in matters of ethnology very little that was precise was obtainable, or at least obtained, by the explorers of those times. It seems very unfortunate that when old customs and people still existed, there were no trained ethnologists, and when the advance of scientific methods has put many ardent explorers in the way, both people and customs have almost vanished from the earth. My honored friend Dr. Charles Pickering, who was the ethnologist of the expedition, did what he could in the "Races of Man", but anthropological measurements were not thought of, or at least wanting, and generalization took the place of the prying questions and minute observations of the present day. Anthropologists today know more about an individual negro than was known in 1840 about the whole Fijian race,—nay, than was known of all the peoples of the vast Pacific Ocean.

---

[16] This is a mistake, as will be seen later on.

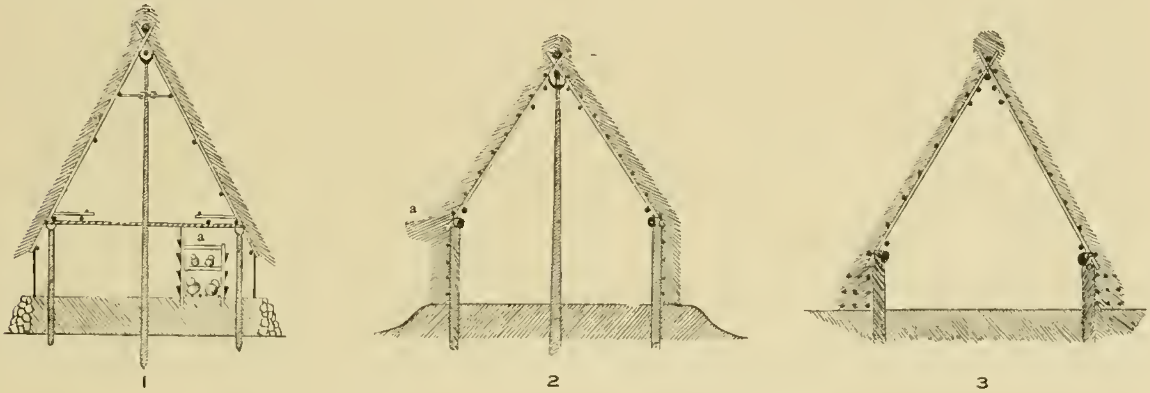


FIG. 19. SECTIONS OF FIJIAN HOUSES.

Until modern methods and instruments shall be employed in an exploration of the islands of the Great Ocean we must be content with the brief, imperfect sketches the old voyagers have given us, illumined here and there by the gleams thrown on these dark places by some missionary, who understanding his own needs studies the people he goes among with the benevolent purpose of saving such souls as they may have from eternal destruction, and by these studies saves many a chapter from the story of their lives which would otherwise have been lost more certainly. To such workers in the vineyard of the Lord every true scientist gives hearty acclamation, whatever he may think of their theological beliefs or teachings. One of the excellent missionaries, the Reverend Thomas Williams, has given in his very interesting and instructive book on this group, where he worked many years, the following account of housebuilding there:[17]—

> The form of the houses in Fiji is so varied, that a description of a building in one of the windward islands would give a very imperfect idea of those to leeward, those of the former being much the better. In one district a village looks like an assemblage of square wicker baskets; in another, like so many rustic arbours; a third seems a collection of oblong hayricks with holes in the sides,

---

[17] Fiji and the Fijians, 2 vols. London, 1858. I, p. 79.

while in a fourth these ricks are conical. By one tribe just enough framework is built to receive the covering for the walls and roofs, the inside of the house being an open space. Another tribe introduces long centre posts, posts half as long to receive the wall-plates, and others still shorter, as quarterings to strengthen the walls; to these are added tie-beams, to resist the outward pressure of the high-pitched rafters, and along the side is a substantial gallery, on which property is stored. The walls or fences of a house are from four to ten feet high; and, in some cases, are hidden on the outside by the thatch being extended to the ground, so as to make the transverse section of the building an equilateral triangle. [3, Fig. 19.] The walls range in thickness from a single reed to three feet. Those at Lau (windward) have the advantage in appearance; those at Ra (leeward) are the warmest. At Lau the walls of Chief's houses are three reeds thick, the outer and inner rows of reeds being arranged perpendicularly, and the middle horizontally, so as to regulate the neat sinnet-work with which they are ornamented. At Ra, a covering of grass or leaves is used, and the fastenings are vines cut from the woods; but at Lau sinnet is used for this purpose, and patterns wrought with it upon the reeds in several different colours. A man, master of difficult patterns, is highly valued, and his work certainly produces a beautiful and often artistic effect.[18] Sometimes the reeds within the grass walls are reticulated skilfully with black lines. The door-posts are so finished as to become literally reeded pillars; but some use the naturally carved stem of the palm-fern instead. Fire-places are sunk a foot below the floor, nearly in the centre of the building, and are surrounded by a curb of hard wood. In a large house, the hearth is twelve feet square, and over it is a frame supporting one or two floors, whereon pots and fuel are placed. [1, Fig. 19.] Sometimes an elevation at one end of the dwelling serves as a divan and sleeping place.

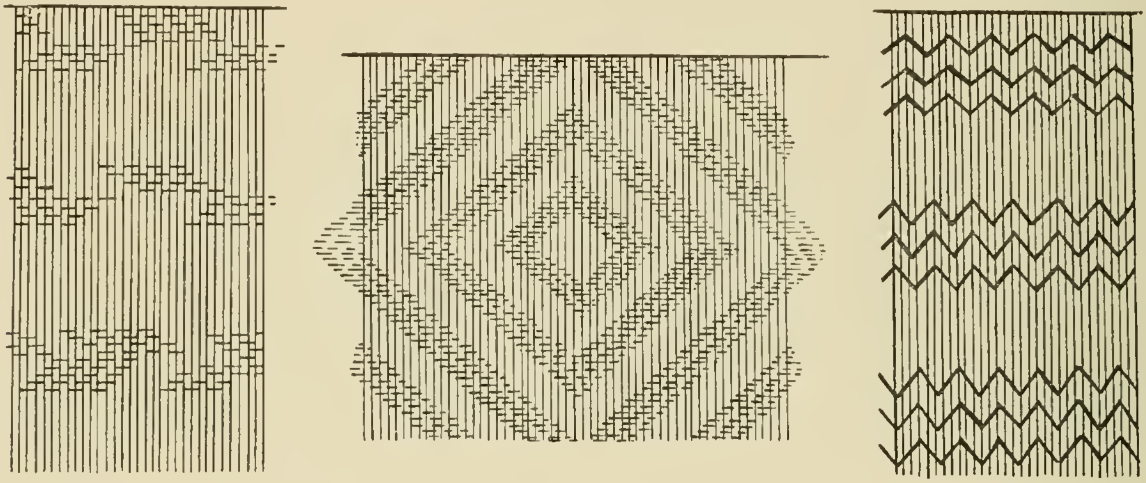


FIG. 20. SINNET WORK ON WALLS, FIJI.

Slight houses are run up in a short time. When at Lakemba, I passed a number of men who had just planted the posts of a house twenty feet long. I was away, engaged with a Tongan Chief, for about an hour and a half, and on my return was amazed to see the house finished, except the completing of the ridge. An ordinary house can be built in a fortnight; the largest require two or three months. A visitor, speaking of Tanoa's[19] house, says, "It surpasses in magnitude and grandeur anything I have seen in these seas. It is one hundred and thirty feet long, forty-two feet wide, with massive columns in the centre, and strong, curious workmanship in every part." Excellent timber being easily procured, houses from sixty to ninety feet long, by thirty feet wide, are built, with a framework which, unless burnt, will last for twenty years. The wood of the bread-fruit tree is seldom used; *vesi* the green-heart of India, *buabua*, very like box-wood, and *cevua*, bastard sandal-wood, being more durable. A peculiarity of the Fijian pillar spoils its appearance. Where the capital is looked for, there is a long neck just wide enough to receive the beam it supports. A pillar two feet in diameter is thus cut away at the top to about six inches.

---

[18] This work should be compared with the similar work of the Maori shown below.

[19] A remarkable Chief of Mbau, father of Thakombau the cannibal king of Mbau and later of all Fiji, who was converted to Christianity largely by the counsel and example of George Toubou, King of Tonga.

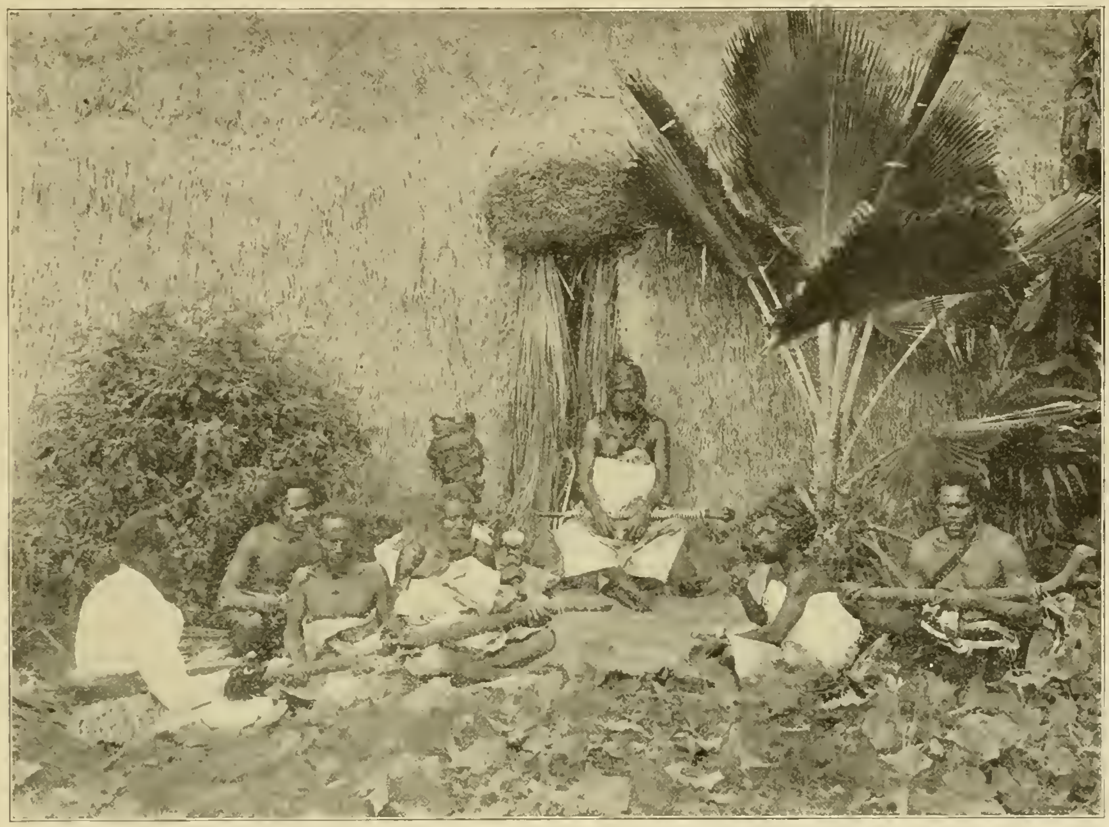


FIG. 21. DOOR OF A FIJIAN HOUSE TO SHOW THE PENT.

Ordinary grass houses have no eaves [3, Fig. 19]; but there is over the doorway a thick semi-circular projection of fern and grass, forming a pent. [2, Fig. 19 and Fig. 21.] Some houses have openings for windows. The doorways are generally so low as to compel those who enter to stoop. The answer to my inquiry why they were so, often reminded me of Proverbs xvii, 19.[20] Although the Fijian has no mounted Arab to fear, he has often foes equally subtle, to whom a high doorway would give facility for many a murderous visit.

Temples, dwelling-houses, sleeping-houses, kitchens, (Lau) inns or receiving houses for strangers (*mbure ni valagi*), and yam stores are the buildings of Fiji.

For thatching, long grass, or leaves of the sugar-cane and stone palm, are used. The latter are folded in rows over a reed, and sewn together, so as to be used in lengths of four or six feet, and make a very durable covering. The leaves of the sugar-cane are also folded over a reed; but this is done on the roof, and cannot be removed, as the other may, without injury. The grass or reed thatch is laid on in rather thin tiers, and fastened down by long rods, found ready for use in the mangrove forests, and from ten to twenty feet long, and secured to the rafters by split rattans. Some very good houses are covered first with the cane leaves, and then with the grass, forming a double thatch. Sometimes the eaves are made two feet thick with ferns, and have a good effect; but, when thicker, they look heavy, and, by retaining the wet, soon rot.

---

[20] He that raiseth high his gate seeketh destruction.

The ridge of superior buildings receives much attention. The ends of the ridgepole project for a yard or more beyond the thatch, having the extremities blackened, and increasing with a funnel-shape, and decorated with large white shells (*Ovulum ovum*). The rest of the ridge is finished as a large roll bound with vines, and on this is fixed a thick, well-twisted grass cable; another similar cable is passed along the under side of the roll, having hung from it a row of large tassels. All foreigners are struck with the tasteful character of this work, and lament that its materials are not more durable. I have seen several houses in which the upper edge of the eaves was finished with a neat braid. The thatchers, contrary to the statement in the "U. S. Exploring Narrative," always begin at the eaves and work upwards.

A more animated scene than the thatching of a house in Fiji cannot be conceived. When a sufficient quantity of material has been collected round the house, the roof of which has been previously covered with a net-work of reeds, from forty to three hundred men and boys assemble, each being satisfied that he is expected to do some work, and each determined to be very noisy in doing it. The workers within pair with those outside, each tying what another lays on. When all have taken their places, and are getting warm, the calls for grass, rods, and lashings, and the answers, all coming from two or three hundred excited voices of all keys, intermixed with stamping down the thatch, and shrill cries of exultation from every quarter, make a miniature Babel, in which the Fijian—a notorious proficient in nearly every variety of halloo, whoop and yell—fairly outdoes himself. All that is excellent in material or workmanship in the Chief's houses, is seen to perfection and in unsparing profusion in the *mbure* or temple.

An intelligent voyager observes:

> In architecture the Fijians have made no mean progress; and they are the only people I have seen, among those classed by Europeans as savages, who manifested a taste for the fine arts; while, as with the ancient Greeks, this taste was universal.[21]

I think my reader will agree with me that Mr. Williams has given us a very complete account of the Fijian house and its building; I can hear the noise of its builders as I recall similar scenes in the Hawaiian Islands and elsewhere in the Pacific—the Fijian has no monopoly of noise, and if he can beat a modern Hawaiian game of "bawl" I am much mistaken. Dr. Pickering is right in his estimate of the artistic tendencies and even achievements of this interesting group of cannibals, for this they certainly were when they in some former day contrived the plan and form of their houses which possess at least one prime requisite of true Art, pleasing and satisfying to a cultured mind. There is but one tribe in the Pacific that can contest the supremacy in architecture with them, and this too is a people of inveterate cannibalistic tastes, the Maori of New Zealand. I have elsewhere called attention to the curious fact that anthropophagous people seem to produce the most elaborate ornamentation, and here I must add to their credit the most artistic housebuilding. If the Fijian excels in beauty of form and proportion, the Maori excites our surprise and pleasure in his carved work, which as used in housebuilding seems to take the lead.

---

[21] Pickering's "Races of Man", p. 155.

There is a chapter of Fijian housebuilding that has been omitted from all the accounts already quoted, but which I do not propose to skip, for the matter is also a part of Hawaiian practice as well; I refer to the human sacrifice usual at the planting of the corner posts (or at least of one) of any important building, whether it be for the use of the gods or of the chiefs. I quote from an author thoroughly cognizant of Vitian customs, Lorimer Fison:[22]

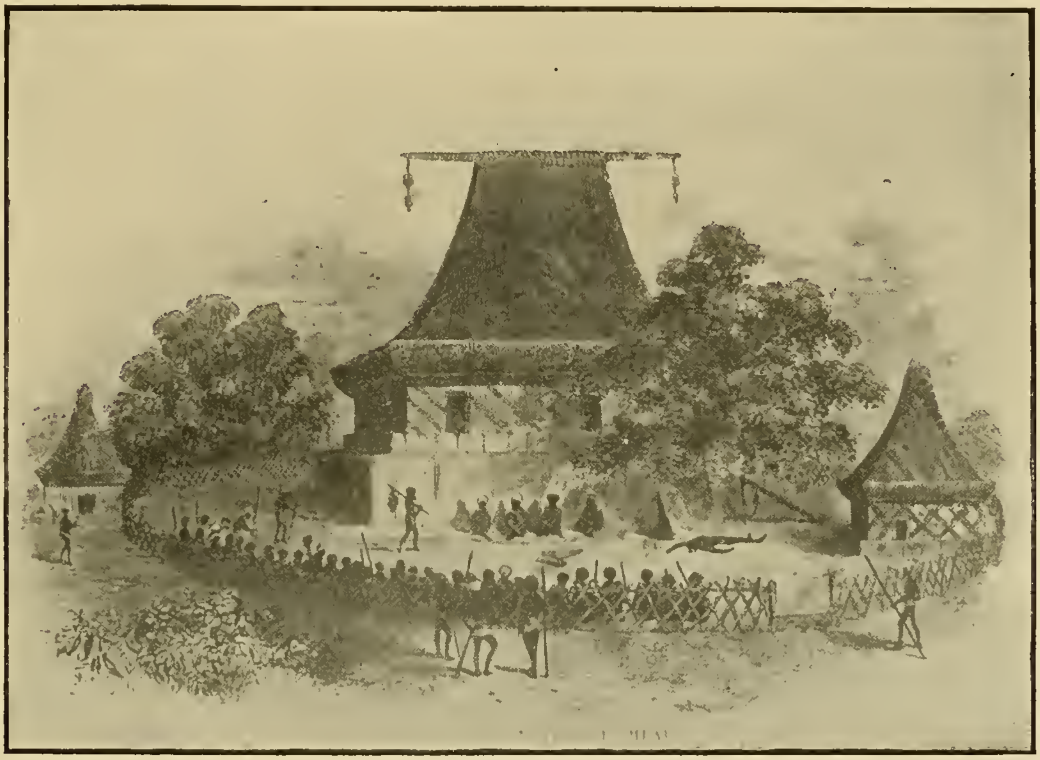


FIG. 22. VIEW OF A MBURE IN MBAU.

> The *Vaka-sombu-ninduru*, literally, the "lowerers of the post", were men killed when the corner-posts of a heathen temple, or a great chief's house, were lowered into the holes dug for them. The god in whose honor the temple was being erected, or the chief whose house was building, would be dishonored if no human life were taken when the posts were set up; and it used to be of no uncommon occurrence for a living man to be placed standing in each post-hole, and there buried alive by the side of the post, the hole being filled up and the earth rammed down over him. But a few years ago there were houses in Fiji, on whose floor the babe and its mother slept, and little children played, while within hand-reach underground grim skeletons stood embracing the corner posts with their

---

[22] Tales from Old Fiji, by Lorimer Fison. London, 1904. xv.

> fleshless arms. It is even probable that there are houses of this description still standing at the present day. At the root of this horrible practice we may doubtless recognize the once widespread superstition that the sacrifice of a human victim, when a foundation was being laid, propitiated the gods and secured the stability of the building.
>
> When the house timber was cut and ready for hauling from the forest, then also men were slain who were called *Yara-ninduru* or "draggers of the post"; the setting up of the first pair of rafters was celebrated by a cannibal feast, whose victims were called *Lalawa-ni-sa*, or "rafter tiers", and when the building was finished other unfortunate wretches were killed and eaten. These were known as *Vaka-voti-voti*, a word whose etymology I am unable to explain.

In another place Mr. Fison tells of an old chief in a corner of whose dwelling were buried some fifteen of his children, most of them murdered by their father, so it would seem unlikely that these people had arrived at the luxury of a haunted house! It will be noticed that with exception of the post victims, the offerings were eaten, not simply offered to the gods.

Lest this custom of the Pacific Islanders, which shocks the modern feelings, should be considered a mark of especial depravity or hardness of heart, let me state that even in Christian countries and in the case of Christian churches the survival of this human sacrifice is a matter of history, and modern history at that. I quote from S. Baring-Gould's "Strange Survivals", 1895, p. 13:

> In 1885, Holsworthy parish church was restored, and in the course of restoration the south-west angle wall of the church was taken down. In it, embedded in the mortar and stone, was found a skeleton. The wall of this portion of the church was faulty, and had settled. According to the account of the masons who found the ghastly remains, there was no trace of a tomb, but every appearance of the person having been buried alive and hurriedly. A mass of mortar was over the mouth, and the stones were huddled about the corpse as though hastily heaped about it, then the walls were leisurely proceeded with.

The tradition of the ramparts of Copenhagen given by Thiele in his "Danish Folk-tales" is, there can be no doubt, founded on fact. As the walls of the ramparts would not stand firm on the poor foundation, the builders took a little girl, placed her in a chair by a table on which were sweetmeats and playthings to amuse her, and then a dozen masons rapidly built a vault over her, covering it with earth, and drowning the innocent child's cries with drums and trumpets. Baring Gould tells us that a few years ago, when the Bridge Gate in the Bremen walls was demolished, the skeleton of a child was actually found imbedded in the foundation. The same author we quote:

> In the walls of the ancient castle of Henneberg, the seat of a line of powerful counts, is a relieving arch, and the story goes that a mason engaged on the castle was induced by the offer of a sum of money to yield his child to be built into it. The child was given a cake, and the father stood on a ladder superintending the building. When the last stone was put in the child screamed in the wall, and the man overwhelmed with self-reproach, lost his hold, fell from the ladder, and broke his

neck. A similar story is told of the castle of Liebenstein. A mother sold her child for the purpose. As the wall rose about the little creature, it cried out, "Mother I still see you!" Then later "Mother I can hardly see you!" And lastly, "Mother I see you no more!"

The Roman had, however, substituted for human sacrifice the offering of other animals. Livy tells us (xxii, 57), "Interim ex fatalibus libris sacrificia aliquot extraordinaria facta: inter quae Gallus et Galla, Graecus et Graeca, in Foro Boario sub terra vivi demissi sunt in locum saxo conseptum, jam ante hostiis humanis, minime Romano sacro, imbutum."

Mahometans vied with Christians in these human sacrifices to secure stability of walls, and the well authenticated case of Geronimo of Oran, a Christian who was bedded in a block of concrete September 18, 1569, and the block built into the wall of a fort near the Bab-el-oved, Algiers, seems the last recorded instance of these human sacrifices. In 1853 the block was removed from the wall and the remains with the cast of the head are now in the Cathedral of Algiers.

So late as 1843, when a new bridge was to be built at the University town of Halle, in Germany, the people assured the architect and masons that they could never make the piers stand unless they first immured a living child in the foundation. During the Boxer troubles in China, it was charged against the Christian missionaries that they were trying to get Chinese children to build into the wall of a new church (much as the Christians have repeatedly charged the Jews with stealing Christian children for sacrifice), and it is not astonishing when we consider the words of Scripture, understood literally by an uneducated and partly hostile audience, "Ye also, as living stones, are built up a spiritual house" (I Peter, ii, 5), and the familiar hymn,

Blessed city, heavenly Salem,
  Vision dear of peace and love,
Who of living stones upbuilded,
  Art the joy of heaven above.

Let us not then blame the Polynesians for a superstition which seems world wide and powerful enough to survive and be a moving force to the present day among some of the Asiatic nations.

I have before me some charming views of Fijian houses taken by my friend J. W. Lindt, the distinguished photographer of Melbourne, which will give my reader pleasure as well as instruction if they can be reproduced with the beauty of the originals. These are on Plates XVIII and XIX. The first shows Na Kali village on the shore of Viti Levu, and the inhabitants as well as their dwellings are brought vividly before us. The builder of the principal house has utilized a great rock in piling up his platform, and this does not extend beyond the walls of the house. The usual pent is distinct over each door; and the ridge seems more neatly finished than the rest of the house thatch; the water comes to the platform and the waterward door has a steep log ladder that only bare feet could safely pass. In such a peaceful scene we can forget the skeleton in the posthole: Fijian houses have no closets!

The lower figure on the same plate shows a long house under the spreading branches of a breadfruit tree, a house that distinctly shows eaves. This is in Waitovu village on the island of Ovalau. The rustic scene surely seems far from the cannibalism of ancient times, and the fierce Fijian has as peaceful home as the indolent Tahitian.

In Plate XIX the upper figure represents the palace of the king of Mbau, the little island noted for the warlike character of its people, where Tanoa and his better known son Thakombau lived. The house has windows,—the first of this foreign innovation we have seen in Fiji; and the cottage perched upon the neat fence is an equal novelty. The way in which the ridgepole is bound to the thatch is clearly shown, especially in the smaller building. The fine canoe in the foreground shows that the house is along the shore and not on the higher part of Mbau. As the Hawaiians, so the Fijians hugged the shore, and in many of the Fijian islands it is difficult to travel inland; all intercourse is by water. Less than a century before this picture was taken, such a canoe as that shown would have been launched by its savage owner on rollers each a human being!

The lower figure shows a house of ordinary form built on the ground, and in the absence of the protecting platform, the low stakes outside the door keep out the pigs, a contrivance sometimes used by the Hawaiians in similar circumstances. The young woman coming from the house has a ladder of bambu neatly bound together with sennit, and her basket suggests an expedition for breadfruit.

New Zealand Houses.—Although Tasman discovered New Zealand he never landed there, and until Cook landed there a century and a quarter afterwards, the civilized world knew nothing of the inhabitants except that they had murdered some of Tasman's crew. Cook spent nearly a year about the group, but his report gives us little information about the housebuilding. What is known as Cook's First Voyage was edited by Dr. Hawkesworth from such material as he found in the journals of all the officers of the expedition. In this we read:[23]

> Their houses are the most inartificially made of anything among them, being scarcely equal, except in size, to an English dog-kennel; they are seldom more than eighteen or twenty feet long, eight or ten broad, and five or six high, from the pole that runs from one end to the other and forms the ridge, to the ground; the framing is of wood, generally slender sticks, and both walls and roof consist of grass and hay, which, it must be confessed, is very tightly put together; and some are

---

[23] Cook's First Voyage, III, 437.

also lined with the bark of trees, so that in cold weather they must afford a very comfortable retreat. The roof is sloping, like those of our barns, and the door is at one end, just high enough to admit a man, creeping upon his hands and knees: near the door is a square hole, which serves the double office of window and chimney, for the fire-place is at that end, nearly in the middle between the two sides: in some conspicuous part, and generally near the door, a plank is fixed, covered with carving after their manner; this they value as we do a picture, and in their estimation it is not an inferior ornament; the side walls and roof project about two feet beyond the walls at each end, so as to form a kind of porch, in which there are benches for the accommodation of the family. That part of the floor which was allotted for the fire-place, is enclosed in a hollow square, by partitions either of wood or stone, and in the middle of it the fire is kindled. The floor along the inside of the walls, is thickly covered with straw and upon this the family sleep. Some of the better sort, whose families are large, have three or four houses enclosed within a court yard, the walls of which are constructed of poles and hay and are about ten or twelve feet high.

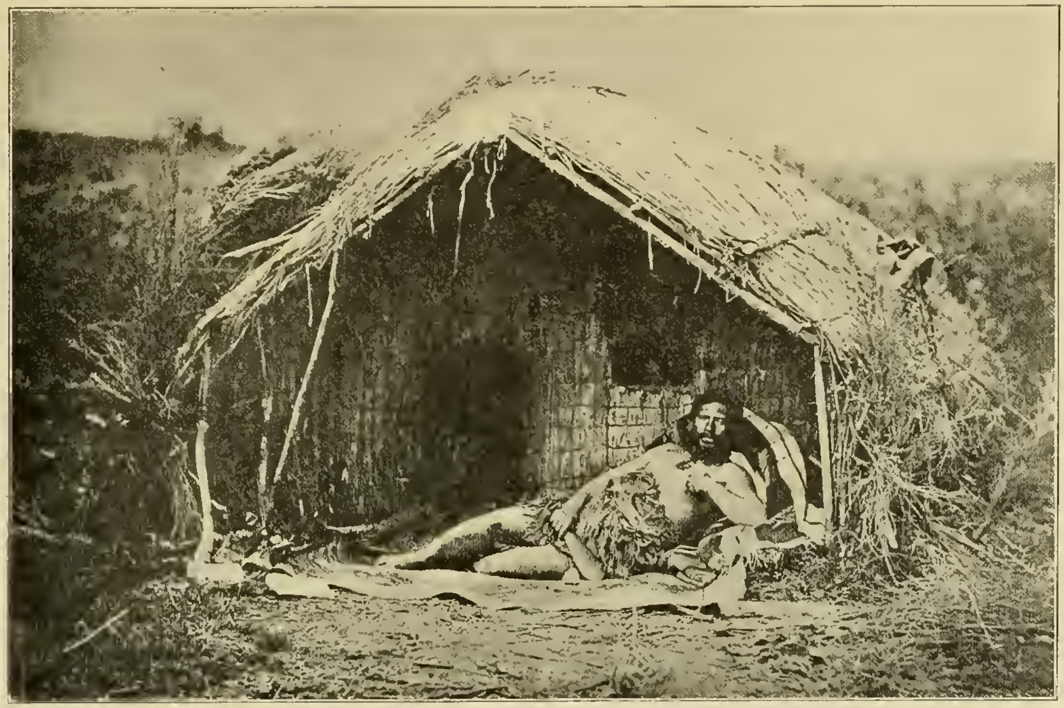


FIG. 23. MAORI HOUSE.

When we were on shore in the district called Tolaga, we saw the ruins, or rather the frame of a house, for it had never been finished, much superior in size to any that we saw elsewhere; it was thirty feet in length, about fifteen in breadth, and twelve high; the sides of it were adorned with many carved planks, of a workmanship much superior to any other that we had met with in the country; but for what purpose it was built, or why it was deserted, we could never learn.

This carved house, we shall see presently, was one of the buildings that make the Maori architecture noteworthy, but in the meantime we may note what Cook himself says in his Journal (p. 223) which has only recently (in 1893) been published exactly as the great navigator wrote it:

The Houses of these People are better calculated for a Cold than a Hot Climate; they are built low and in the form of an oblong square. The framing is of wood or small sticks, and the sides and Covering of thatch made of long Grass. The door is generally at one end, and no bigger than to admit of a man to Creep in and out; just within the door is the fireplace, and over the door, or on one side, is a small hole to let out the Smoke. These houses are twenty or thirty feet long, others not above half as long; this depends upon the largeness of the Family they are to contain, for I believe few Familys are without such a House as these, altho' they do not always live in them, especially in the summer season, when many of them live dispers'd up and down in little Temporary Hutts, that are not sufficient to shelter them from the weather.

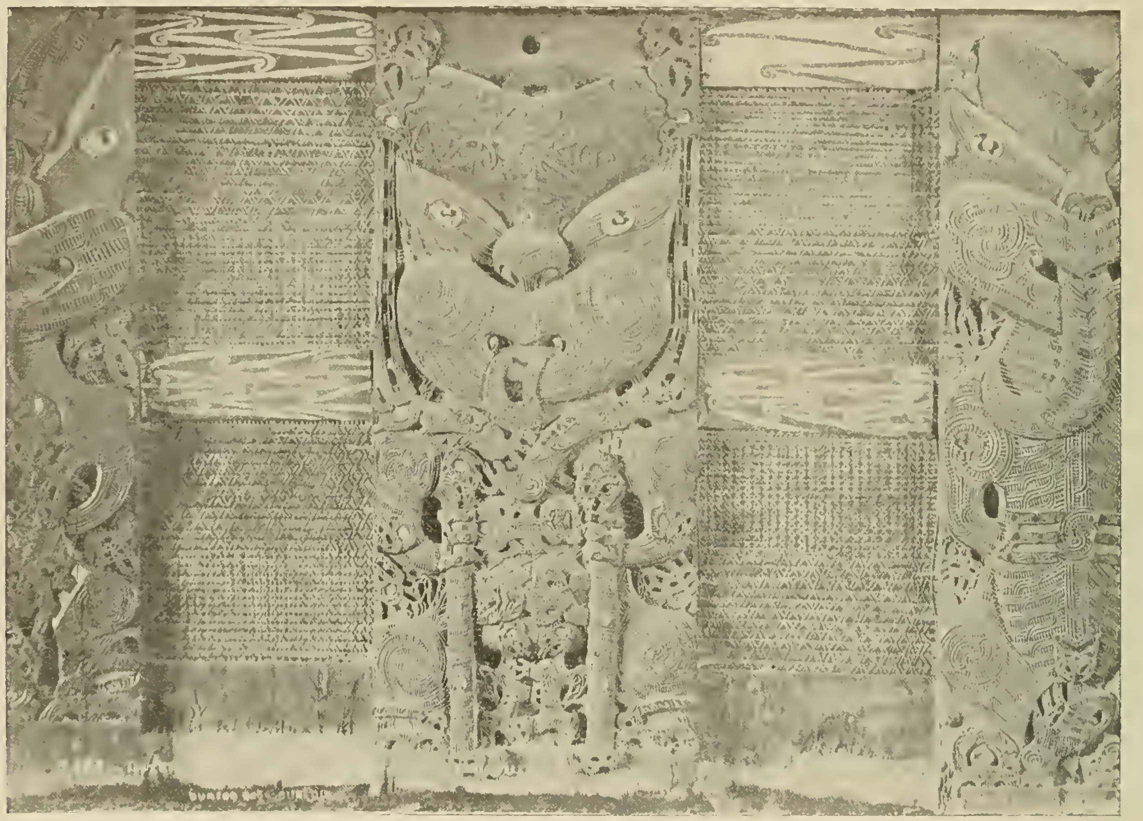


FIG. 24. POUPOU AND TUKUTUKU AT OHINEMUTU.

This is the first group of those whose housebuilding we have glanced at, that extends beyond the Tropics and, in the southern part, into a decidedly cold climate. Snow-capped mountains with glaciers and extensive mountain lakes lower the temperature even in summer, and we should naturally expect a very different form of building from the veranda-like houses of Tahiti or Samoa. While hurricanes do not visit New Zealand as they do Fiji, Samoa, and the southeastern Pacific generally, yet the prevailing winds are in places very severe, as at Invercargill, where trees hardly venture to grow above the shelter of stone walls, and even in the charming city of Wellington there are storms of wind and rain that make a tight house necessary for comfort. On the northern island where the climate passes into the subtropical, the houses of the aborigines are still well enclosed against the weather. In the King Country, on the Wanganui River, I have seen houses such as Cook describes, and others with more or less carved ornamentation. At Ohinemutu in the Hot Spring district are good examples of the carved houses. All of the illustrations are of houses or parts of houses that I have seen, and many of the houses I have examined with some care. I will give one more description of the Maori house in modern time, and it will be seen that there is little difference from the pictures left us by the first discoverers, so far as the general plan is concerned. In the matter of decoration there has undoubtably crept in unmistakable traces of foreign influence, but this is of little importance if we know the fact. The most modern as well as the most complete description of the dwellings of the Maori has been given by Mr. Augustus Hamilton,[24] but to his admirable work

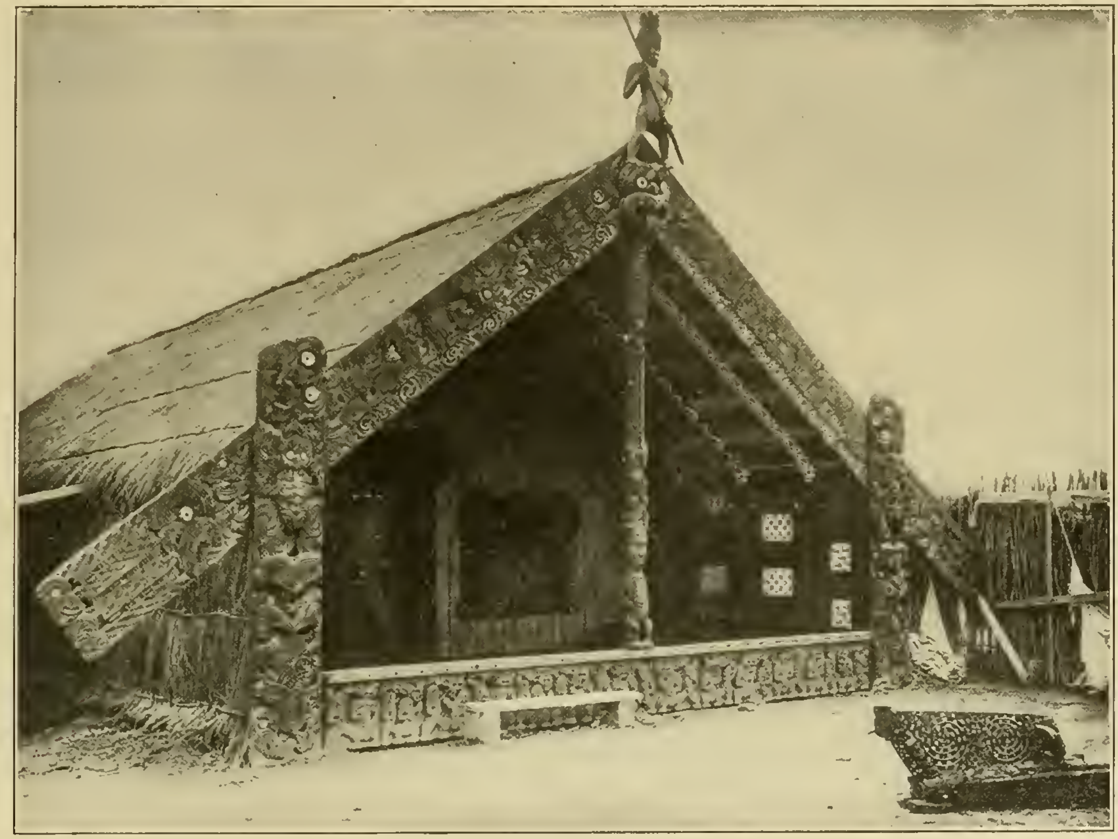


FIG. 25. A MAORI HOUSE.

---

[24] The Art Workmanship of the Maori Race in New Zealand. Dunedin, 1896, p. 79. Published by the New Zealand Institute.

I must refer those who wish to go more fully into the detail of the Maori house, as Mr. Hamilton's work is doubtless accessible in all good libraries. I shall, however, quote from Mr. Hamilton's work where there is need to explain or modify the account, much more brief, given by Rev. Richard Taylor[25] which I have decided to quote in full:

> The European traveller who crawls into a native hut for the first time, will see nothing particularly interesting in it; he will perhaps, only view it as a dark smoky hovel; but when he becomes acquainted with native customs, and observes the order and arrangement displayed, the careful way it is constructed, and how perfectly the object aimed at is attained, he will not withhold its meed of praise.

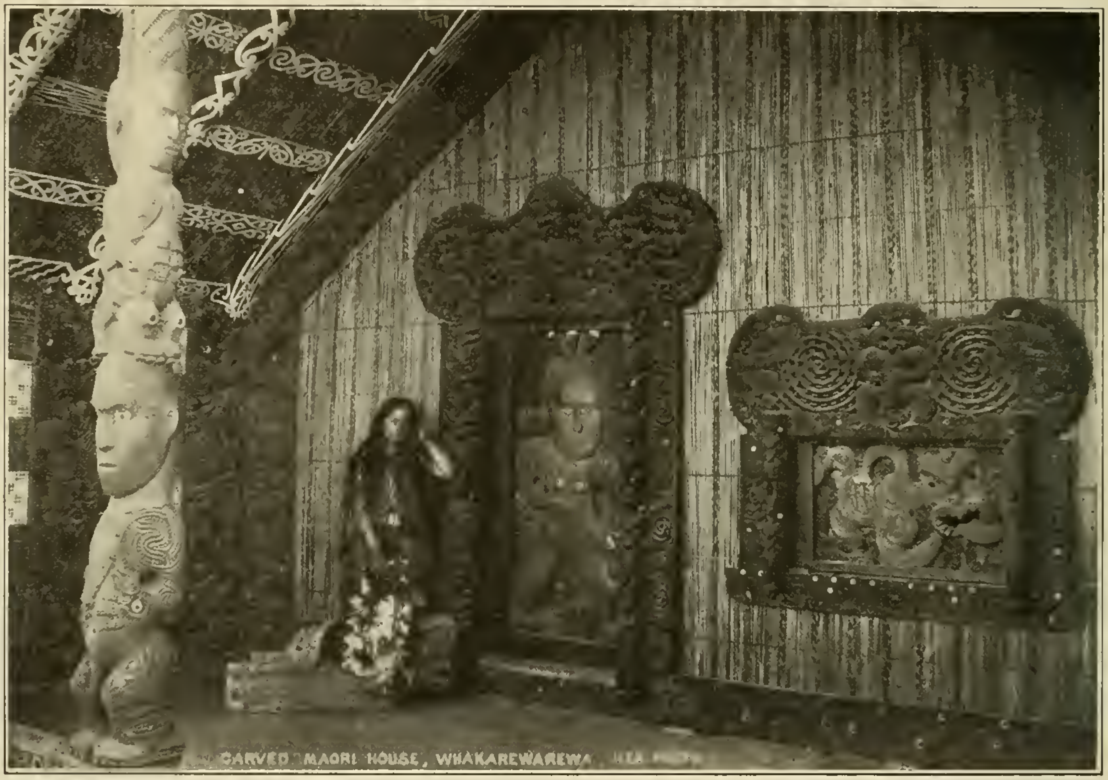


FIG. 26. ENTRANCE OF A MODERN CARVED HOUSE.

> The principal houses are called *whare puni*, or warm houses; this name may be given either from the number of persons generally residing in them, or from their being so built as to exclude the external air; they are usually sunk one or two feet in the earth, and nearly always front the sun; the sides of one are seldom more than four feet high, being formed of large broad slabs of totara (*Podocarpus totara*), the most durable timber, having a small circular groove or opening cut into the top to receive the rafters; these slabs are either adzed, and painted with red ochre, or, if it be a very superior house, each one is grotesquely carved to represent some ancestor of the family, in which case they become a kind of substititute for the nobleman's ancestral picture gallery; between these posts there is generally a space of two feet, which is filled up with a kind of lattice-work, composed

---

[25] Te Ika a Maui; or New Zealand and Its Inhabitants. Second edition. London, 1870, p. 500.

of slender laths, dyed black, white, or red, and bound together with narrow strips of the kiekie (*Freycinetia banksii*) leaf, very tastefully disposed in patterns; this is called arapake; there is also a skirting board (*papa whai*) painted red; and the rafters which are either carved or painted with different colored ochres, rest on a ridge pole (*tahuhu* or *tahu*), in which a notch is cut to receive them. This ridge pole is always the entire length of the building, including that of the verandah, being generally of a triangular shape, and very heavy; it is supported by a post or pillar (*pou tahu*) in the middle of the house, the bottom of which is carved in the form of a human figure representing the founder of the family—and is thus a kind of lares; immediately before the face of this figure is the fire-place, a small pit formed by four slab stones sunk into the ground; perhaps this is some relic of ancient fire-worship in the position of the fire, which, as a domestic altar, always burns before the face of the image of their deified ancestor.

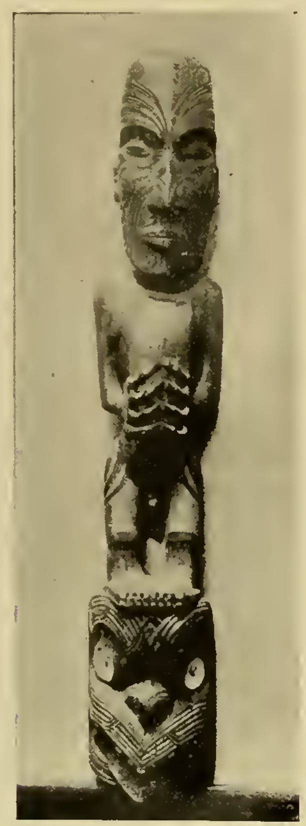


FIG. 27. TEKOTEKO FROM MAORI GABLE.

The entrance to the house is by sliding door (*tatau*), which is formed of a solid slab of wood, about two feet and a half high, and a foot and a half wide; the way of fastening it when the owners were absent, was by means of a stick, which passed through a loop in the door and crossed the side posts; it could of course be opened by any one, but was always regarded as tapu; they were also accustomed to secure their doors by complicated knots, when likely to be absent for any length of time. On the right side of this is a window (*matapihi*), generally about ten inches high and two feet wide; this also is furnished with a slide which goes into the wall of the building; another window is placed in the roof, a kind of trap-door, termed a *pihanga* or *puhanga*, literally gills or lungs, a breathing place, more than an aperture for admitting light, which is not required in a *whare-puni* at night. On entering, there is a low slab of wood on either side, to partition off the sleeping places, leaving a path down the middle, that nearest the door being about eighteen inches high, in which the inmates lay in rows, each with his feet towards the fire, and his head to the wall; the chief, or owner of the house, invariably takes the right side next the window, the place of honor; the next in point of rank occupy those nearest to him, whilst the slaves, and persons of no consequence, go to the furthest end. Their bedding (*wariki*), seldom consists of anything more than one or more ground mats (*waikawa*), upon which sometimes a finer one (*tihenga pora*) is laid, and a round log, or a bundle of fern serves as a pillow (*urunga*). Formerly they never ate in their houses, therefore verandahs (*mahau*) were required. The length of a whare puni is from twenty to thirty feet, and the breadth sixteen; the verandah is seldom more than six feet in depth, being a continuation of the gable end of the house, having the entire width[26] of the one building; it has a broad slab in front, about two feet and a half high, which separates it from the road; from this a post rises to the ridgepole which is surmounted with a caved figure.[27] [Figs. 27 and 28.] The verandah is ornamented in the same way as the interior of the house; its wall plate is often carved to represent the prostrate figures of slaves on whose bodies the pillars which support the house stand; this seems to refer to an extinct custom of killing human victims, and placing them in the holes made to receive the posts, that the house being founded in blood might stand; the custom still prevails in Borneo and other parts. Over the door is a board called *maihi* (also *pare* or *korupe*), elaborately carved, and adorned with bunches of pigeon feathers; the facings of the door-posts and window are similarly ornamented; the building is covered externally with raupo (*Typha angustifolia*) or sedge, and roofed with the same, then with grass or a similar substance, to a considerable thickness; earth is generally heaped up against the sides, so as almost to reach the eaves.

---

[26] This is not quite exact, as the porch was always a little less than the width of the house. See Hamilton, p. 81.

[27] This post, which is common enough in modern houses, seems not to have been usual in those of the olden time. Fig. 25.

At sunset, a fire is made in the house, which is allowed to burn clear for some time, and fill the little pit with embers, when it ceases to smoke the occupants enter; the door and window being closed, the heat soon becomes almost as great as that of an oven, and of such a stifling nature, from the fumes of the charcoal, that few Europeans can bear it, yet frequently twenty, thirty, or more natives will sleep in this place huddled together, and almost in a state of nudity; sometimes even they suffer, from the charcoal being too powerful; this was formerly attributed to the visits of the *patupaiarehe* (fairies).

To the description of Maori dwellings must be added some account of their *pataka* or storehouse, a small structure on which the carver used all his art and industry. Being comparatively portable these pataka of the old Maori have mostly been gathered, either as a whole or in part, into museums and no longer add to the picturesque value of a native village. This small house, for it was merely a reduced model of the whare puni, was raised from the ground on one or more posts, and its general appearance may be understood by reference to Fig. 29, from a photograph of the beautiful specimen preserved in the Auckland Museum. When very small and raised high on a single post, the pataka resembled a bird-house and served as the depositary of a chief's bones which were in due time exhumed, cleaned and thus stored.

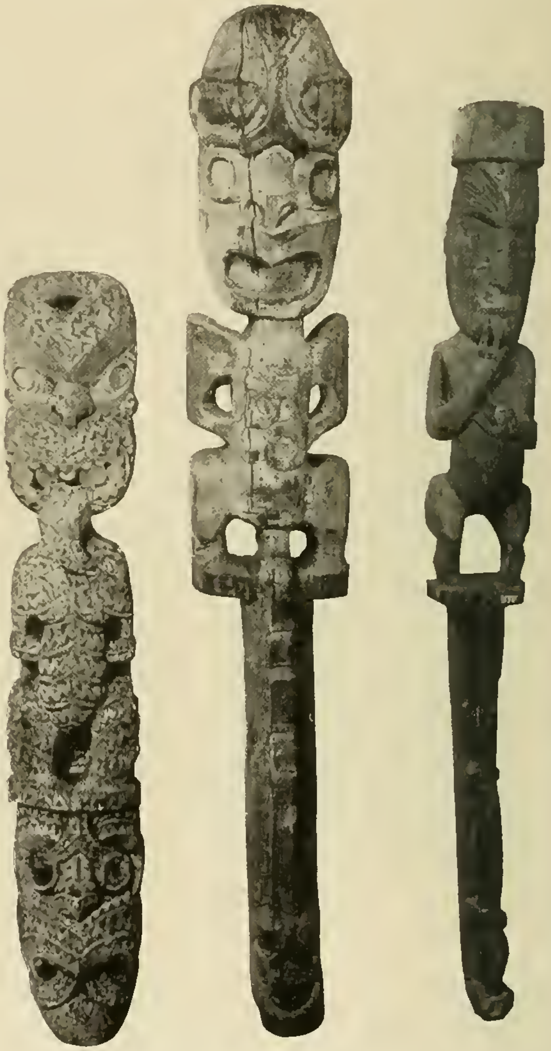


FIG. 28. GROUP OF GABLE IMAGES IN THE BISHOP MUSEUM.

The gable end of a pataka which was perforated by the very small entrance[28] was composed of five or seven thick planks usually of totara wood, on which were carved gods or deified ancestors of the owner, the figure over the door in the centre (Fig. 33) representing the chief ancestor, and the pantheon served to protect (under the tapu system) all treasures stored within, more than locks or human vigilance. These planks were bound to smaller posts intervening by cords of native flax (*Phormium*). As in the case of many, if not most Maori carvings really old, these figures represented facts which in Anglo-Saxon civilization are deemed indecencies, often so gross that they are not pictured by the foreign artist: to the Maori they did not so appear, nor do I believe they were made, as were many of the sculptures and paintings revealed by the excavations at Pompeii, to pander to mere sensuality. That they were often caricatures of realities is true, and such examples amused rather than in any other way disturbed the Maori.

---

[28] Two of these pataka fronts in the Bishop Museum have doors averaging 22×17 inches. As they were reached by a ladder, it must have been very awkward to take bulky articles out. In some cases these pataka were built in shallow lakes and reached by boats.

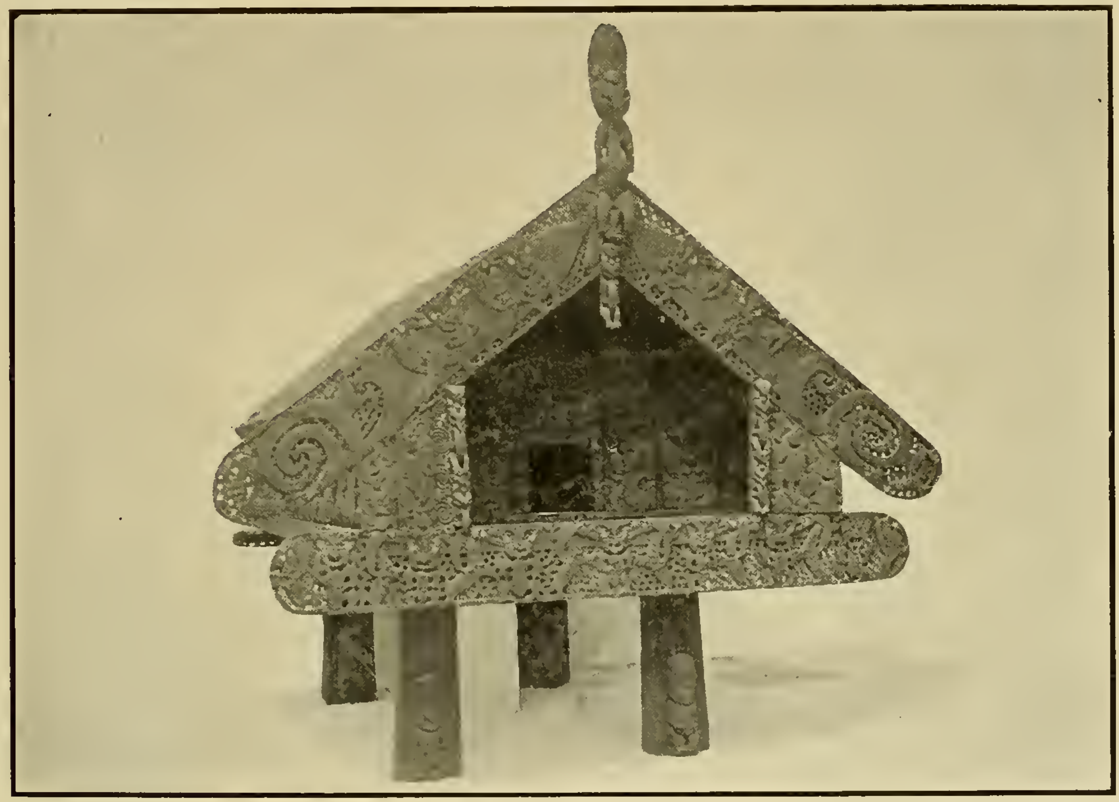


FIG. 29. PATAKA IN AUCKLAND MUSEUM.

In many Maori carvings of human or superhuman heads the eyes are represented by nacreous shell (*paua—Haliotis iris* and *H. stomatæformis*) cut in ring form and attached by a projection of the dark wood which represents the pupil. Bunches of feathers are also often attached to the cords tying the structure together.

The principal carvings, to recapitulate, that distinguish a Maori *Whare kopae* are, within the house the *poupou* or heavy carved slabs serving as posts, of which Fig. 30 one from the Rununga whare or Council house of the pa at Maketu, supposed to have been carved in 1820, and now in the Bishop Museum, gives a fair idea. These were generally memorials of the ancestors, human or divine, of the builder and not infrequently show a great amount of patient work. Even to the present day there are Maori skilled in this work, and with the white man's chisel the work is much lightened. Fig. 35. The principal post, *poutokomanawa*, supporting the ridge-pole, was carved in the lower portion in a more realistic way (see Fig. 32), and I have seen an outstretched hand from one of these figures that might have been the work of a competent European sculptor.

Externally the sculpture was expended on the gable front of these houses, as may be seen in several of the illustrations given. Of these the *amo*, of which a fine pair from Tarawera is shown in Pl. XXII, supported the lower end of the *maihi* or barge-boards; the latter supporting at the peak a figure, usually a mask (*koruru*), above which is the *tekoteko*. As shown in the illustration (Fig. 25) these images were of varied form, often grotesque, but always possessing some attributed power of protection, and so strong was this that the *tapu* often withheld the hand of the victorious enemy who had killed the inmates from disturbing the house; if the owners were all dead no one would despoil it even for firewood. Over the door was an elaborate carving called *pare* or *korupe*, one of which is shown in Pl. XXII. This rested on the *whakawae* or *ngawaewae*. The fancy of the Maori sculptor had free play on these lintels and they are among the most artistic Maori monuments in museums. Besides the one figured this Museum possesses another carved

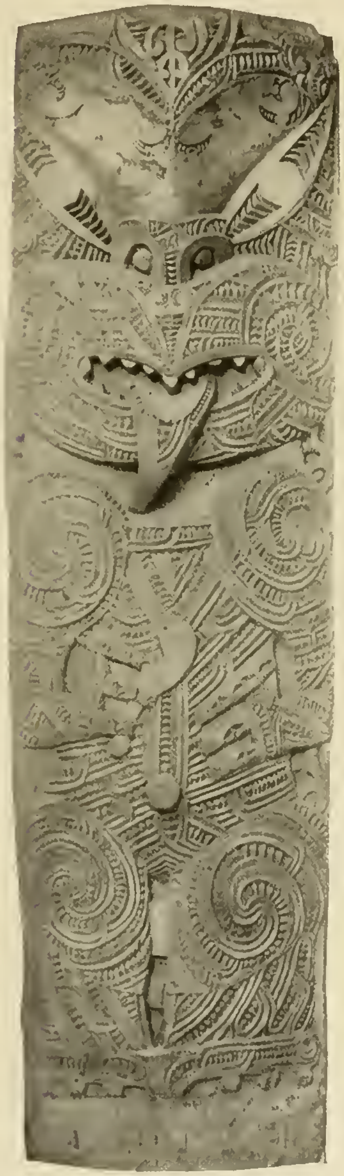


FIG. 30. POUPOU FROM MAKETU.

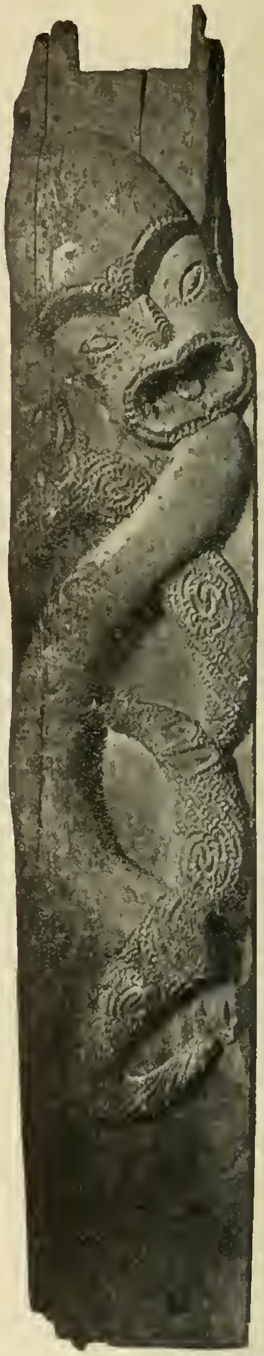


FIG. 31. A MAORI MYTHICAL FORM ON A HOUSE SLAB.

by the grandfather of Matangi, an old man in 1820. Thus dating from the time of Cook's visit, or perhaps earlier.

The ngawaewae were, in the old houses, very short; a fine pair in this Museum from Tetaheke, Lake Rotoiki, shown in Pl. XXII, measures only thirty inches in height, but with the advent of foreigners the height of the doorway increased, and modern carved ngawaewae are made high enough to accommodate a tall foreigner; one of these is shown in Fig. 26. In the modern work the old design, however, still appears, one figure upon another. The round bellies of the figures, the curious three-fingered hand, the fingers of one or the other hand inserted in the mouth, the mouth itself recalling the mouth of the Hawaiian idols, who also have the same oblique eye, all are repeated in most of the doorposts I have seen. A section of one of these ngawaewae is of L form, the figures occupying the short arm, while the longer one is decorated with Maori arabesques.

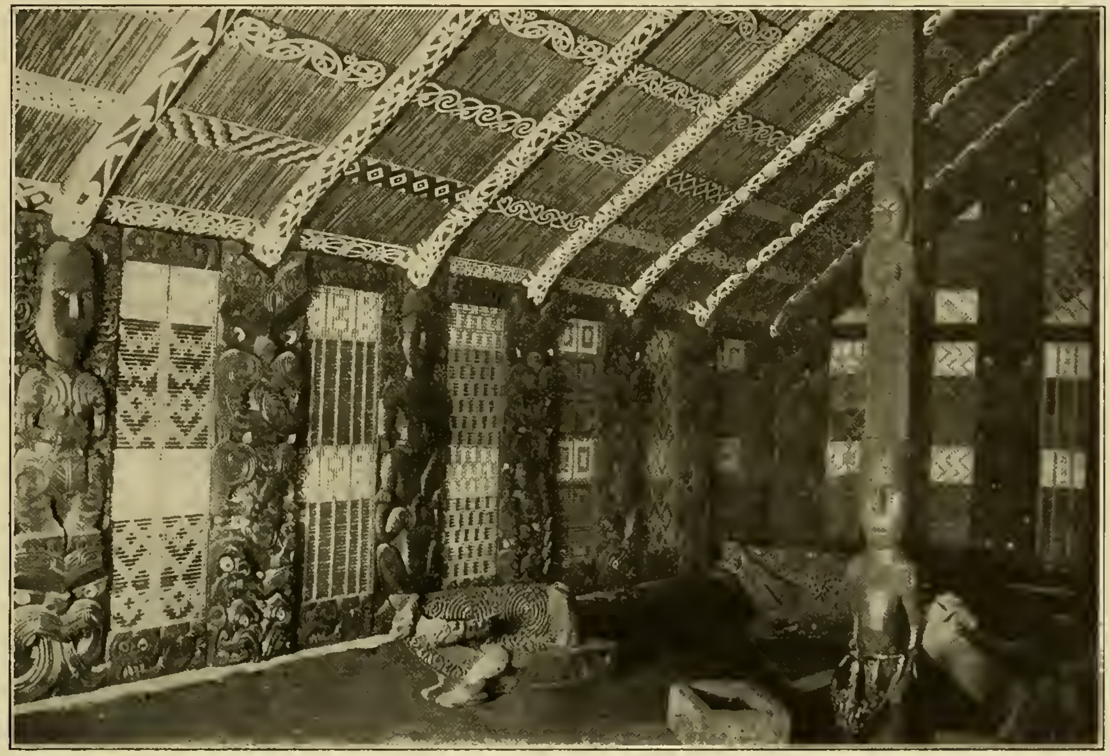


FIG. 32. INTERIOR OF MAORI HOUSE, ROTORUA.

In the fine doorway shown in Fig. 33 the same figures are at either side of the door. The main figure over the door has so large a head that the remarkable device of two necks does not seem unreasonable. In the Fig. 34, the central slab of a fine pataka in the Bishop Museum, the interlaced strap pattern of the ground is good even for old

Maori design. The main figure holds a *patu* in which is an English penny. The door has been fastened by an old English lock, of which the keyhole is seen on the right. While the human figures in Maori carving seem grotesque in the extreme, the mythical animals frequently found in sculptured decoration out-herod Herod. The Maori was well able to treat his subject *ad naturam*, and if he distorted the actual models before him, he had his reason, and it was not lack of power; but when his subject was a *taniwha* he perhaps

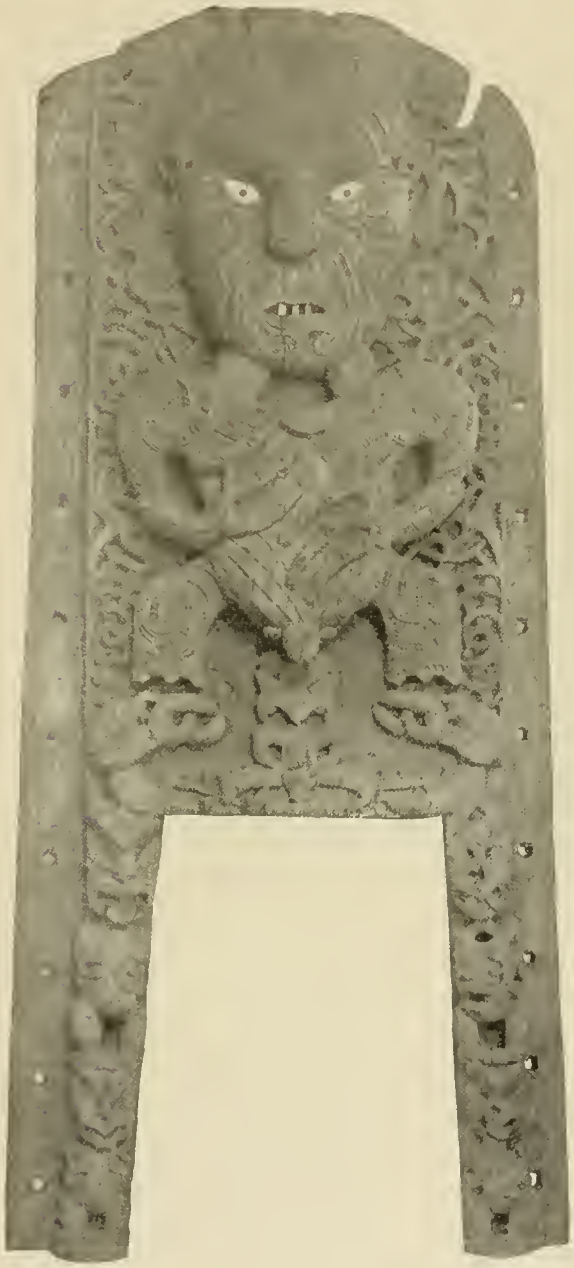


FIG. 33. DOORWAY OF PATAKA.

(In the Bishop Museum.)

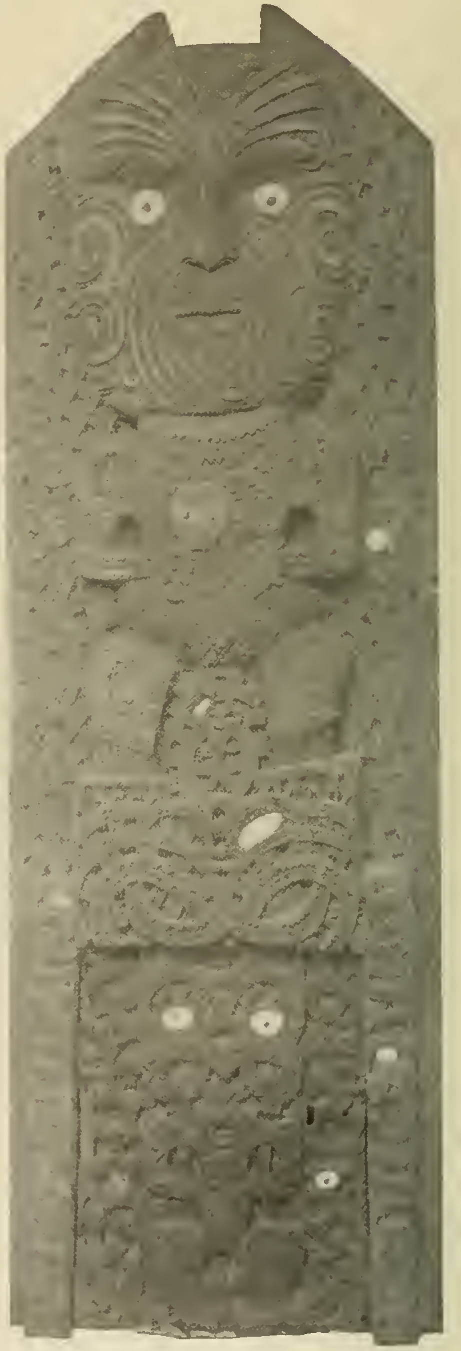


FIG. 34. CENTRAL SLAB OF PATAKA

came as near the idea as the Greek in his Chimæra or Hydra. The figure given in illustration (Fig. 31) is a remarkably fine bit of old carving, in private hands in Auckland, when I saw it a few years ago. Other carved slabs were found with it buried in a swamp, and on all the carving was of the highest order, although in some places decayed. The designs were often remarkably obscene to the Anglo-Saxon sense, although proper enough to the Maori.

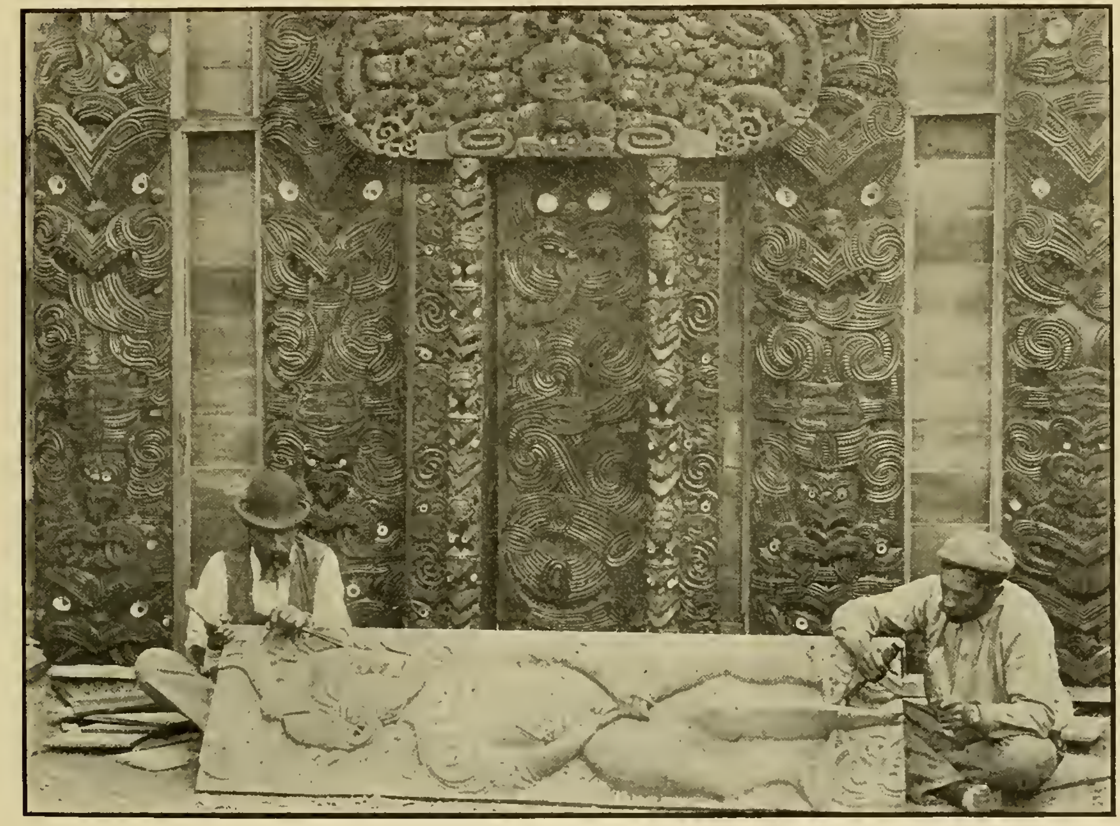


FIG. 35. NEW ZEALANDERS CARVING A POUPOU.

It may be repeated that the strange figures on the *poupou* or other parts of the Maori house represented ancestors, human or divine, of the owner of the house, and the faces bear the *moko* or carved face decoration which was distinct in each head, and cut on the living flesh much as the sculptor carved it on his block of wood. An old Maori could have told who the carved face portrayed from the pattern of the moko.

Union Group.—We may now return to the mid-Pacific, not far from Samoa, and between that group and the equator in about 9° S. lies the Union Group, consisting of the three low islands Atafu or Oatafu (Duke of York Id.), Nukunono (Duke of Clarence Id.) and Fakaafo (Bowditch). Byron, who discovered Atafu in 1765, reported it uninhabited. There are some sixty-three islets covered with coconut and pandanus trees, and the atoll is now under British protectorate as are the two others. Nukunono was discovered by Captain Edwards in the *Pandora* in 1791, and Fakaafo by Captain Hudson of the U. S. Exploring Expedition in 1840.

The houses on these islands at the time of the visit of the Exploring Expedition as we see them in the drawings of Mr. T. C. Agate, one of the artists of the expedition, are not only typical of the *stick and thatch* method of building, but very beautiful examples of that architecture now almost extinct in this region (Fig. 36). Captain Hudson visited a village on the shore of the lagoon and describes it as containing—

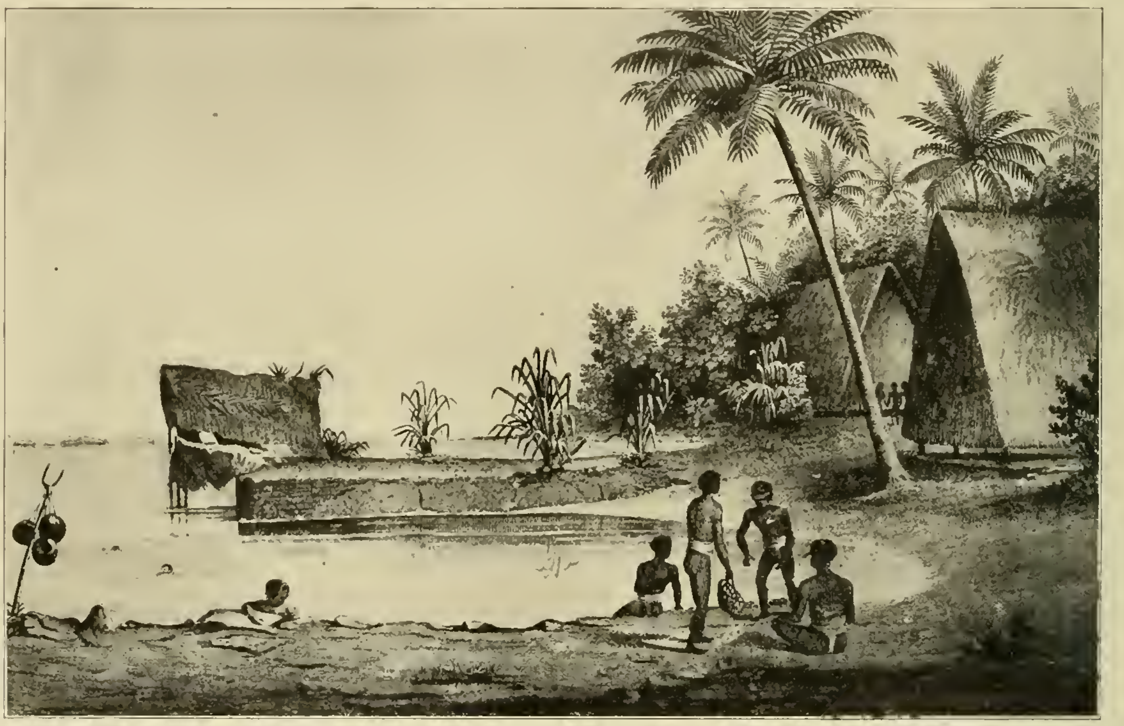


FIG. 36. SCENE ON ATAFU. DRAWN BY T. C. AGATE.

> ....about thirty houses which were raised about a foot above the surrounding earth; they were of oblong shape, about fifteen feet high to the ridge-pole, sloping gradually and of a convex form to within two or three feet of the ground; the roof [ridge-pole] was supported on high posts, whilst the lower part rested on short ones, three feet within the eaves having a strong piece extending around, on which the rafters were tied; the gable-ends were overtopped by the roof, and seemed necessary to protect them from the weather. Below the eaves the whole was open from the ground to the roof. The thatching, made of pandanus-leaves, was of great thickness, and put on loosely. The interior of the houses was very clean, but there was no furniture except a few gourds, and a reclining stool, cut from a solid block of wood, having two legs at one end, which inclined it at an angle of nearly forty-five degrees; to show the manner of lying in it, they imitated a careless

> and comfortable lounge which they evidently considered a luxury. It was conjectured that they had removed their various household utensils to a secret place.
>
> The most remarkable constructions of the islanders near the village, were three small quays, five or six feet wide and two feet above the water, forming slips about ten feet wide : at the end of each of these was a small house, built of pandanus leaves, partly on poles in the water [See Fig. 36]. * * * * * * They have no water on the island, and the supply is wholly obtained from excavations made in the body of the cocoanut trees, two feet from the ground. These trees are all dug out on the lea side, towards which all are more or less inclined. These excavations are capable of containing five or six gallons of water.[29]

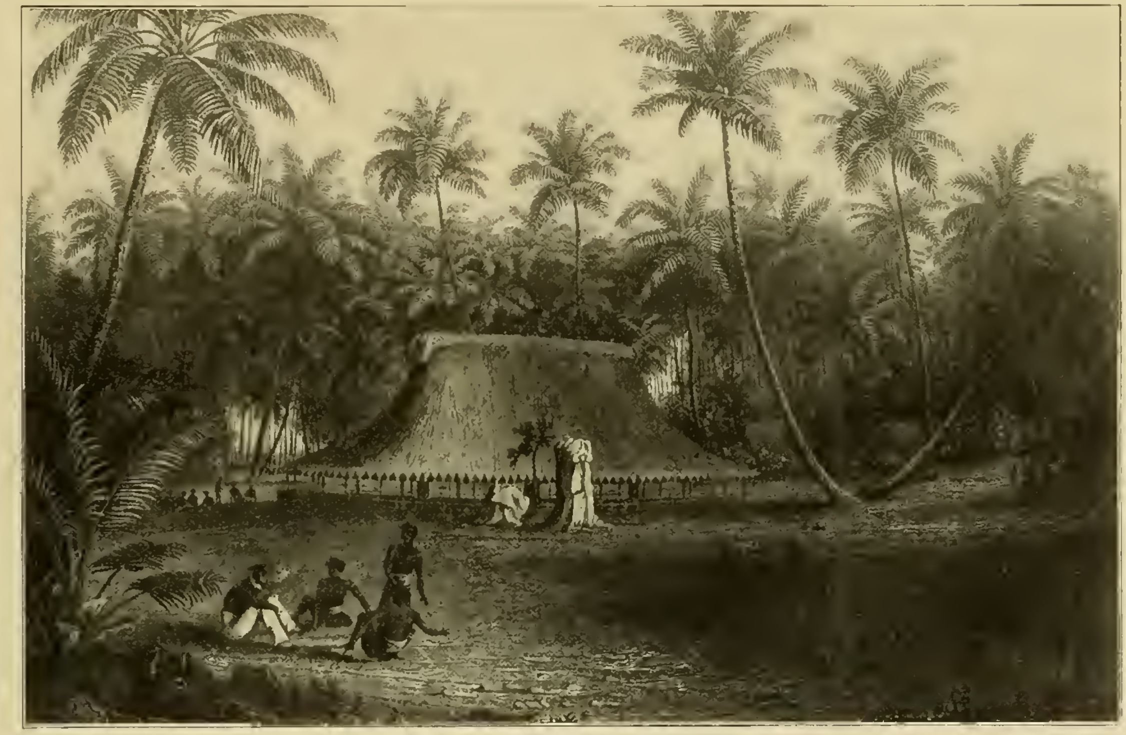


FIG. 37. COCONUT GROVE AND HOUSE ON FAKAAFO. AGATE.

The boats of the expedition were not able to land on Nukunono and sailed southward, discovering Fakaafo. On this new island they found the dwellings much like those they had seen on Atafu, but better built. Quoting again from the Narrative (v, p. 14):

> The most remarkable building was that which they said was their *tui tokelau* (house of their god). This stood in the centre, and was of an oblong shape, fifty by thirty-five feet, and about twenty feet in height. The roof was supported in the centre by three posts, two feet in diameter, while under the place on which the rafters rested, were many short and small posts : all were very roughly hewn, and placed only a few feet asunder. The roof was concave and extended beyond the posts at the eaves ; the thatching was tied together, which, hanging down, resembled at a distance the curtain of a tent or marquee. All the sides were open, excepting a small railing, about fifteen inches high, around the foundation, which allowed the free passage of the air through. * * * *

---

[29] U. S. Ex. Exped., v. 7. It is not probable that they had more furniture in their ordinary houses.

The edifice contained but little furniture. Around the eaves a row of mother-of-pearl shells was suspended, giving the appearance of a scolloped curtain. The whole was covered with mats. In the centre, around the largest pillar, a great number of enormous benches, or tables were piled, which were carved out of the solid wood, and being of rude workmanship, were clumsy and ill-shaped. In all probability these were the reclining stools before spoken of. The natives termed them "the seats of their god." Their gods, or idols, *tui tokelau*, were placed on the outside, near by. The largest of these was fourteen feet high and eighteen inches in diameter. This was covered or inveloped in mats and over all a narrow one was passed, shawl-fashion, and tied in a knot in front, with the ends hanging down [Fig. 37]. The smaller idol was of stone and four feet high, but only partially covered with mats. About ten feet in front of the idols was one of the hewn tables, which was hollowed out; it was four feet long by three broad, and the same in height. (Loc. cit., v, p. 14.)

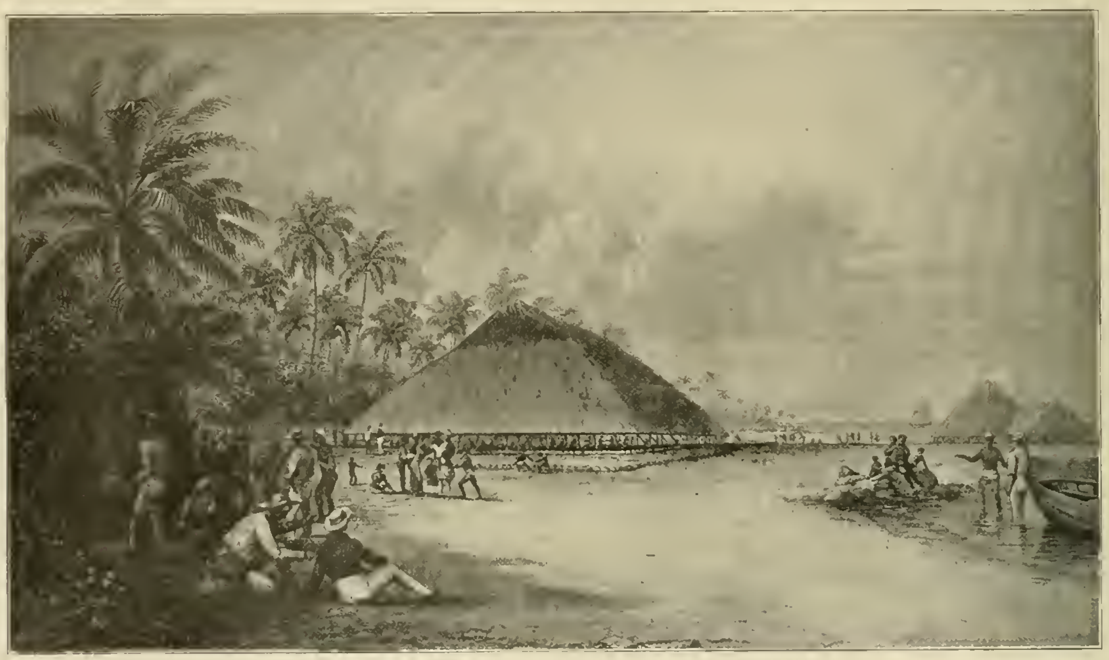


FIG. 38. LARGE MARIAPU AT UTEROA.

Gilbert Islands.—Turning northwestward from the Union Group, we soon enter the region of Micronesia,—the little islands, a vast archipelago stretching many degrees east and west along the equatorial belt and in a way connecting the southeastern Polynesians with the Asiatic races of the Marianas and Pelew Islands on the north of the equator, and through the spurs of the Seniavine and Mortlock groups, with the Papuans of the Bismarck Archipelago and the New Hebrides on the south. The islands of the Gilbert and Marshall groups are low coral atolls,—small islands grouped around a shallow lagoon, generally roughly circular, sometimes mere arcs of the circle remaining. The climate is equatorial throughout, and that and the vegetation and lay of the ground would conduce to uniformity in housebuilding. On Tapiteuea (Drummond), or rather its northern islet Uteroa, the Wilkes expedition landed and, unfortunately, later had to burn the village in punishment for the murder of one of their crew. Wilkes describes their building as follows, and Mr. Agate has given the picture of the principal building (Fig. 38):

> They reached the beach near what the natives termed their "*Mariapu*", or council house, one of the large buildings that had been before spoken of as visible from the sea. This stands in front of the town, on a broad wharf made of coral stones built out from the beach; its dimensions as measured were one hundred and twenty feet long, by forty-five feet wide, and to the ridge-pole forty feet high. The ridge-pole was supported by five large posts whence the roof sloped on each side and reached within three feet of the ground; the rafters descended to a wall-plate which rested on large blocks of white coral, and were also supported by smaller posts ten feet in length, near the sides. At the ends the roof was perpendicular for eight or ten feet, and then they sloped off in the same manner as the sides. The roof was thatched with pandanus leaves. (Loc. cit., v, p. 55.)

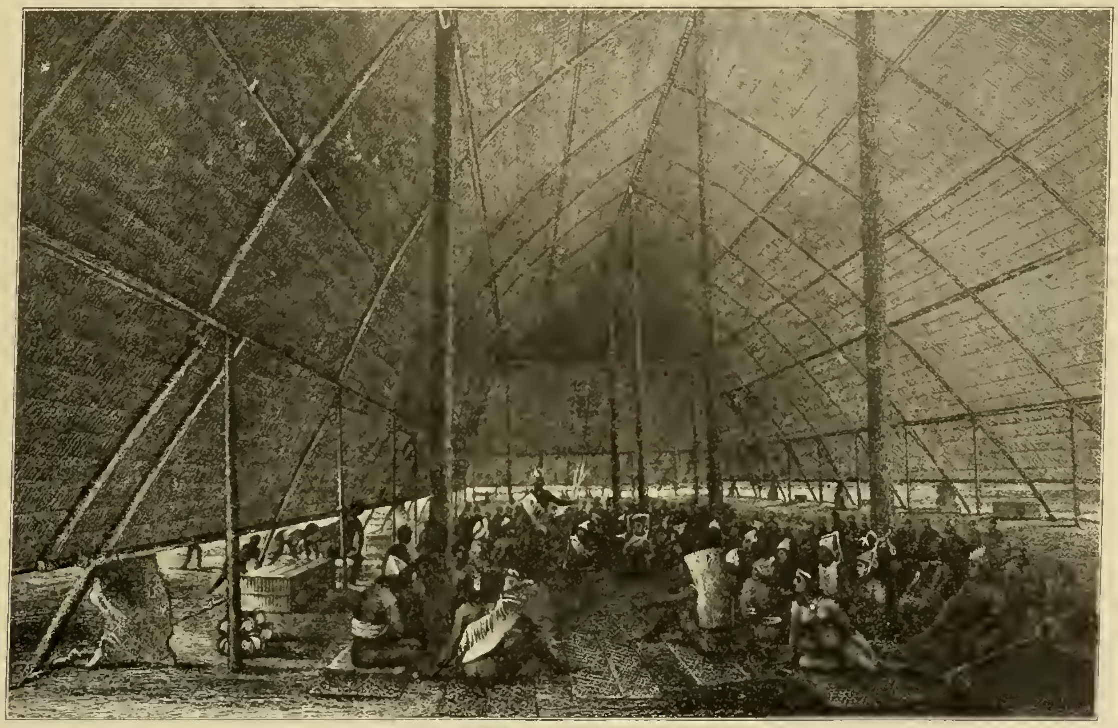


FIG. 39. INTERIOR OF MARIAPU.

> The Mariapu was a very large building, and in the interior [Fig. 39] its architecture showed to much advantage: the ridge-pole with the rafters, were painted in black bands, with points, and ornamented with a vast number of ovule shells. Chests made of the thin laths of the pandanus, somewhat resembling cane, were arranged around, about twenty feet apart: these contained only a few mats and cocoanuts, things of no value, and are supposed to be for the accommodation of visitors or used at their feasts. The floor was in places covered with mats of the cocoanut leaves [p. 59].

Near this was a dwelling of the better sort which they thus describe:

> There was nothing remarkable in its exterior; it was of oblong shape, and about sixteen feet wide by twenty feet long. The interior consisted of two stories, of which the lower one was not more than three feet high, under the floor of the upper story. It was entered by a square hole on one side.

The apartment above was rather a loft or garret, which was high and contained apparently all the valuables and goods of the occupant. The floor was made of small pieces of pandanus boards laid on slender beams of cocoanut wood. * * * * The lower apartment is used for sleeping, while the upper entirely for storing their goods and chattels. The wall-plates rest on four beams of cocoanut wood, which are supported by four posts at each corner. These posts are round and perfectly smooth so that the rats cannot climb them. The rafters and cross-pieces are mere poles only an inch or two thick; the thatch is of pandanus-leaf doubled over a slender stick and tied down with sennit. (p. 56.)

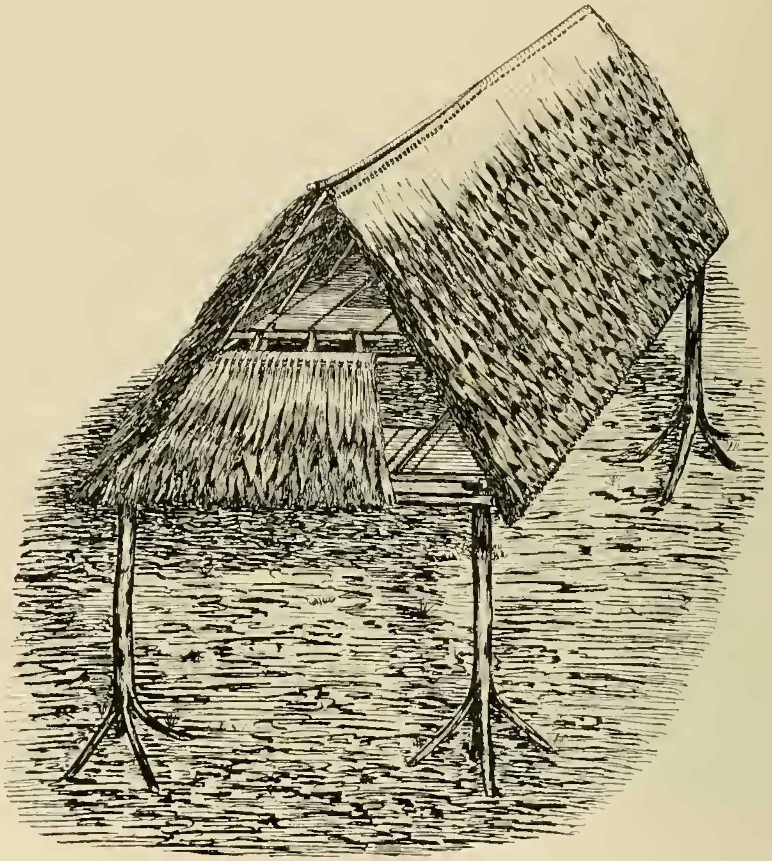


FIG. 40. MODEL OF A MAIANA HOUSE.

Here we have the first attic in the Pacific architecture; indeed the first suggestion of a second story. The upper beams used as shelves for various articles, in the Samoan, Tongan and Marquesan houses have now developed into a garret. From the island of Maiana we have in the Bishop Museum a carefully constructed model of a house (see Fig. 40) given by the Reverend William Lono, formerly a missionary of the Hawaiian Board to the Gilbert Islands, now the pastor of the Kaumakapili Church in Honolulu. In this we have a still farther developement. Like the houses of Tapeteuea it is supported on four smooth corner posts, probably for the same reason, but the first floor contains a room of ample height, with an opening in the floor of such extent as to place the remaining floor in the class of gallery. The entrance is through this aperture by a rude ladder,[30] which is removable, and there is no opening on the sides of the house on this story. The height of the first floor above the ground is quite sufficient to keep pigs and other intruding animals out. The floor aperture admits light, serves for ventilation, and the easy removal of rubbish. Above this is another gallery with a diminished opening in the centre, the floor of the attic store room. This is well ventilated at each gable, one, indeed being left open. There is a double ridgepole as in the Hawaiian house.

---

[30] Rev. Hiram Bingham D.D., who was for years a missionary in the Gilbert Islands, assures me that they seldom used ladders to get into the comparatively low floor.

Kusaie.—From the low islands of the Gilbert archipelago we turn to the high volcanic islands that appear here and there in Micronesia. Conditions having changed, the housebuilders have planned in other ways. The possession of stone (utterly wanting in the coral islands), again suggests the platform as a good house foundation, and the structure gaining in dignity, we find the houses of the chiefs and well-to-do men exhibiting some architectural features that we have not hitherto seen in our rapid sketch of Pacific housebuilding: as we go west we shall see more, and have perhaps all that the "stick and thatch" house can show.

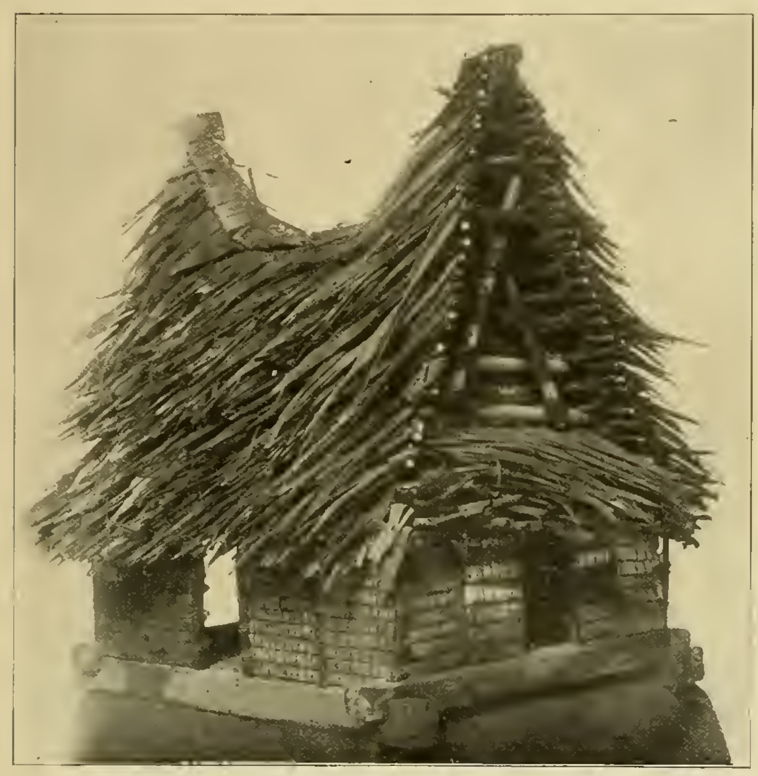


FIG. 41. MODEL OF A KUSAIAN CHIEF'S HOUSE.

In this Museum is a carefully made model of a Kusaian house (Fig. 41) belonging to a chief, which presents a square structure of which the saddle roof is the prominent feature. The walls of the house are, as usual, low and the framework is of squared timbers without cross bracing, the interspaces closed, not with thatch, but with neatly made mats of reeds closely bound together with sinnet, a light and cleanly method. These mats are colored white with lime made from coral, left in the natural color, or decorated with sennit. The four sides have each a small central door. The palm-thatched roof has the peculiar form shown in the figure, and the gable ends, partly open for ventilation, seem to be the most decorated portion of the building. Fig. 42 shows more of the detail, but the sennit patterns in red and black on a white ground should be seen in their fresh color to be justly appreciated. There is a lightness,

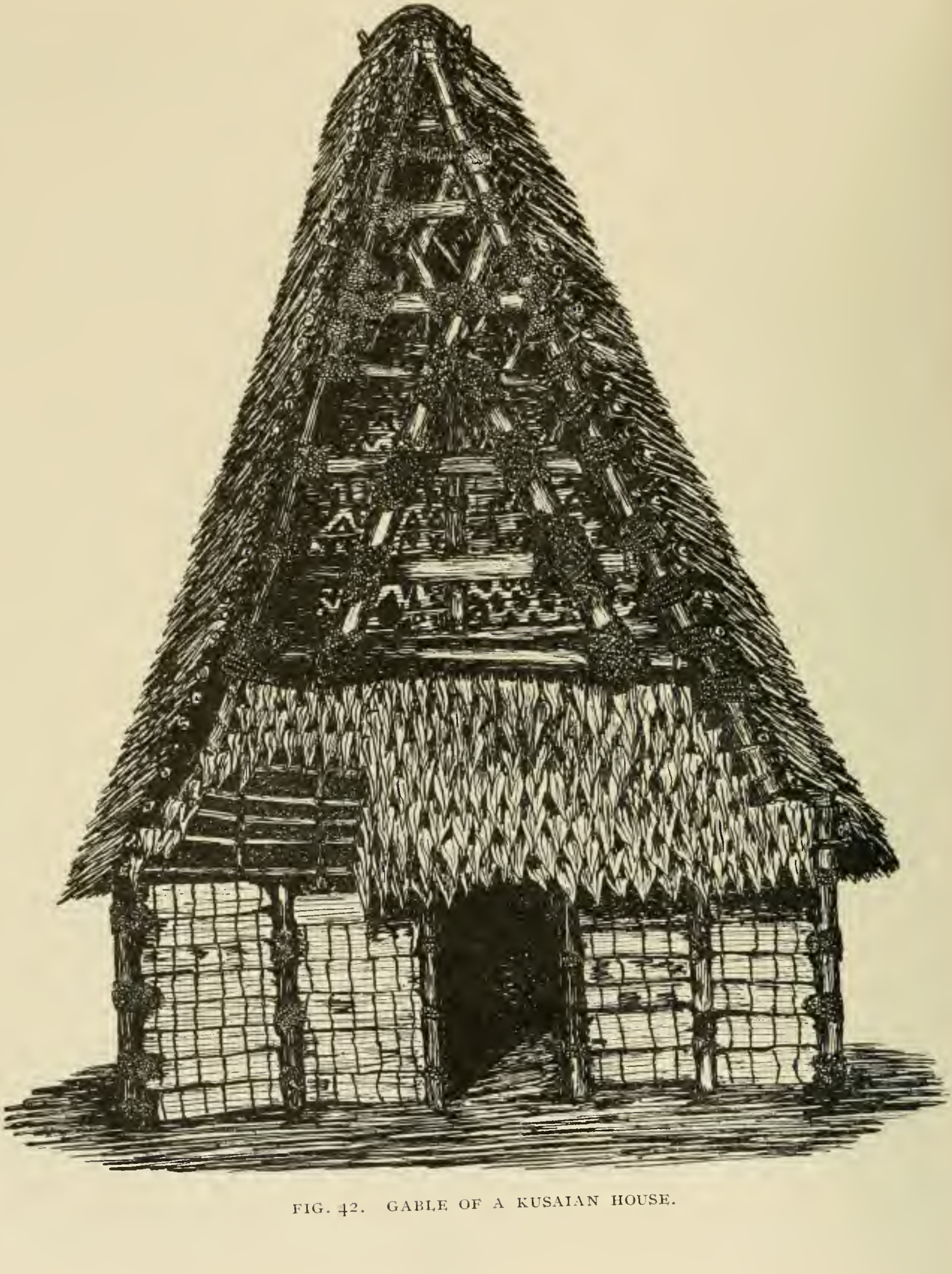


FIG. 42. GABLE OF A KUSAIAN HOUSE.

wanting in the Maori carved house, very attractive in the warmer climate of Kusaie. To these houses, which are of limited size, there are no internal beams and the ridgepole is supported by the triangles shown in the figure of the gable end. The floor is of slats, after the style of the East Indian bambu structures, and while light and cleanly, is hard for a novice to walk upon. Of the interior furnishing I have no particulars.

Ponape.—In Ponapé the houses are built upon platforms as in the Marquesas, Hawaii and elsewhere: and these substructures are four or five feet high, built of basaltic blocks or slabs of coral limestone. The house-walls are low; the beams of the framework squared, and the interspaces filled with panels or curtains composed of reeds or cane not more than half an inch thick, bound together neatly by coconut fibre: the roof is closely thatched with palm leaf, the eaves projecting so as to shade the walls. The narrow doors are a marked feature of these rectangular, shed-like dwellings, which are seldom more than twenty feet high to the ridges.

I pass over the stone structures on the shores of Ponapé, already referred to, because there does not seem sufficient evidence that they were built for human habitation, or if they were, have been more than foundation platforms for ordinary houses.

Pelew Islands.—The story of the happy island as edited by Keate[31] from the journals of Captain Wilson and his officers, pictures an Arcadia seldom met with and assuredly not to be found in the Pacific at the present day. The houses of the amiable people therein depicted are thus described:

> Their houses were raised about three feet from the ground, placed on large stones, which appeared as if cut from the quarry, being thick and oblong; on these pedestals the foundation beams laid, from whence spring the upright supports of their sides, which were crossed by other timbers grooved together and fastened by wooden pins; the intermediate spaces closely filled up with bamboos and palm-leaves, which they plaited so closely and artificially as to keep their habitations warm and exclude all wet; and their being raised from the ground preserved them from any humidity. The floors were in general made of very thick plank, a space of an inch or two being left between many of them. But in some of the houses they were composed of large bamboos split, which being perpetually trodden over, rendered them very slippery. The interior part of the house was without any division, the whole forming one great room. In general the fire-place stood about the middle of it, sunk lower than the floor, with no timber below it, the whole space beneath being filled up with hard rubbish; but in the larger buildings, where they held their public meetings, they had a fire-place at each end. Their fires were in common but small, being mostly used to boil their yams, and to keep up a little flame at night to clear away the dews, and smoke the mosquitoes. Their windows came to the level of the floor, and served both for doors and windows, having stepping-stones at all of them to enter by. To prevent any inconvenience from wind or rain, which so many apertures

---

[31] An Account of the Pelew Islands situated in the Western part of the Pacific Ocean. Composed from the Journals and Communications of Captain Henry Wilson and some of his officers, who, in August, 1783, were there shipwrecked, in the Antelope, a Packet belonging to the Honourable East India Company, by George Keate, Esq., F. R. S. and S. A. London, 1788. 4to. (Second Edition.)

might occasion, each of them had a bamboo frame or shutter, interwoven as the sides of the house were, which sliding on bamboo rods, were easily slipt on one side when anybody wanted to go in or out. On the top of the upright sides beams were laid across from whence sprang the roof, which was pointed like our barns the whole inside being clear; this made their houses within very lofty and airy: the outside of the roof was thatched very thick and close with bamboos or palm-leaves. This was the general form of their houses; some of which were from sixty to eighty feet in length, but these were appropriated to public uses, such as meetings of business, or festivity; at other times they served the natives to assemble in and chat together, where the women usually brought their work and joined in the conversation. Those that were properly domestic habitations, were the same both in shape and texture, though less in dimension. It was remarked that the family kept on one side of the central fire-place, and the servants on the other.

From the same author we learn that the islanders had earthen vessels for boiling their yams, etc., bambu joints for water buckets, adzes of shell (*Tridacna gigas*) including the reversible form known from New Guinea to Hawaii (see these Memoirs, i, p. 419, fig. 85, pl. lx); tortoise-shell dishes and fish-hooks; knives of pearl shell as well as bambu. Their cords and nets were made of coconut fibre, they pinned their house frame together, an East Indian or Asiatic fashion, although pins were used in Maori houses, and in parts other than the main frame in Hawaii, instead of using the Polynesian method of tying with sennit. The almost universal bambu floor of Asiatic cottages, is found in occasional use.

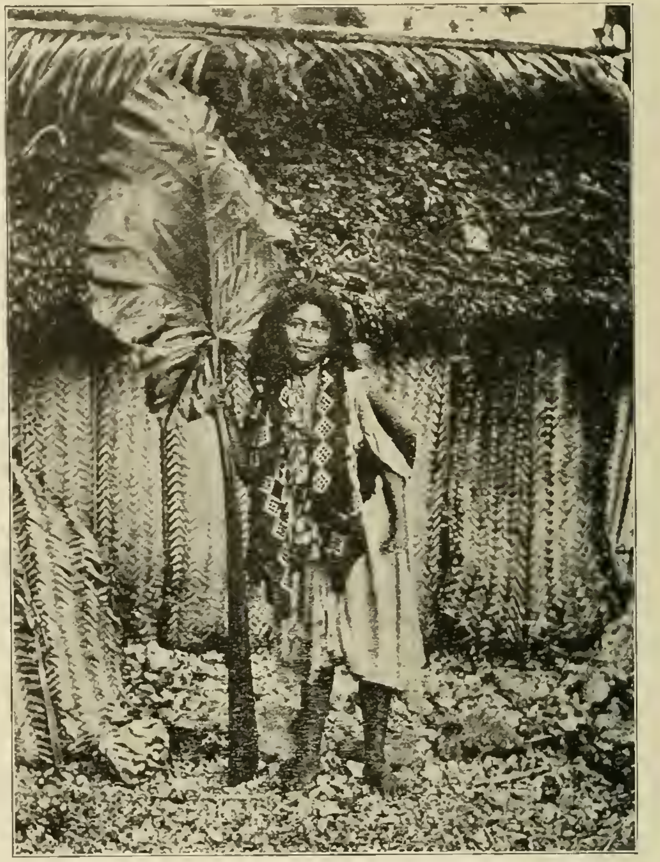


FIG. 43. WOVEN WALLS OF NIUE HOUSE.

An interesting variation in the walls of the thatched house is shown in Fig. 43, where the braided palm leaves are much closer knit than is usual in the Polynesian use of this leaf. The girl of Niue (Savage Id.) in the foreground is holding a leaf of the *apé*, a gigantic form of kalo.

New Guinea.—Sailing south from the Pelew group we come to the great island that we call New Guinea because there is no collective native name. Hostile tribes, many of them practically unknown to this day, speaking dialects mutually unintelligible, most of them cannibals ordinarily or on occasion, with Polynesian settlements dotted along the northern coast, and with dialects almost as many as the villages, small wonder that the architecture seems fantastic and subject to no rule! Pile dwellings built out from the marshy shore, much as the lake dwellers of central Europe built six thousand years ago; tree dwellings high up in the free growing trees of a tropical climate, and between these extremes almost every light and flimsy pattern of house building, from the hut hardly large enough to shelter a single specimen of the naked people of the Papuan race, to the communal house several hundred feet long gathering beneath its huge roof people enough to fill a good sized village—as New Guinea villages go. We could fill a scrap book with pictures of the bizarre structures the explorer meets, but it would be only a scrap book, and we must be content with a bit here and there seen much as a bird may be supposed to see houses in rapid flight.

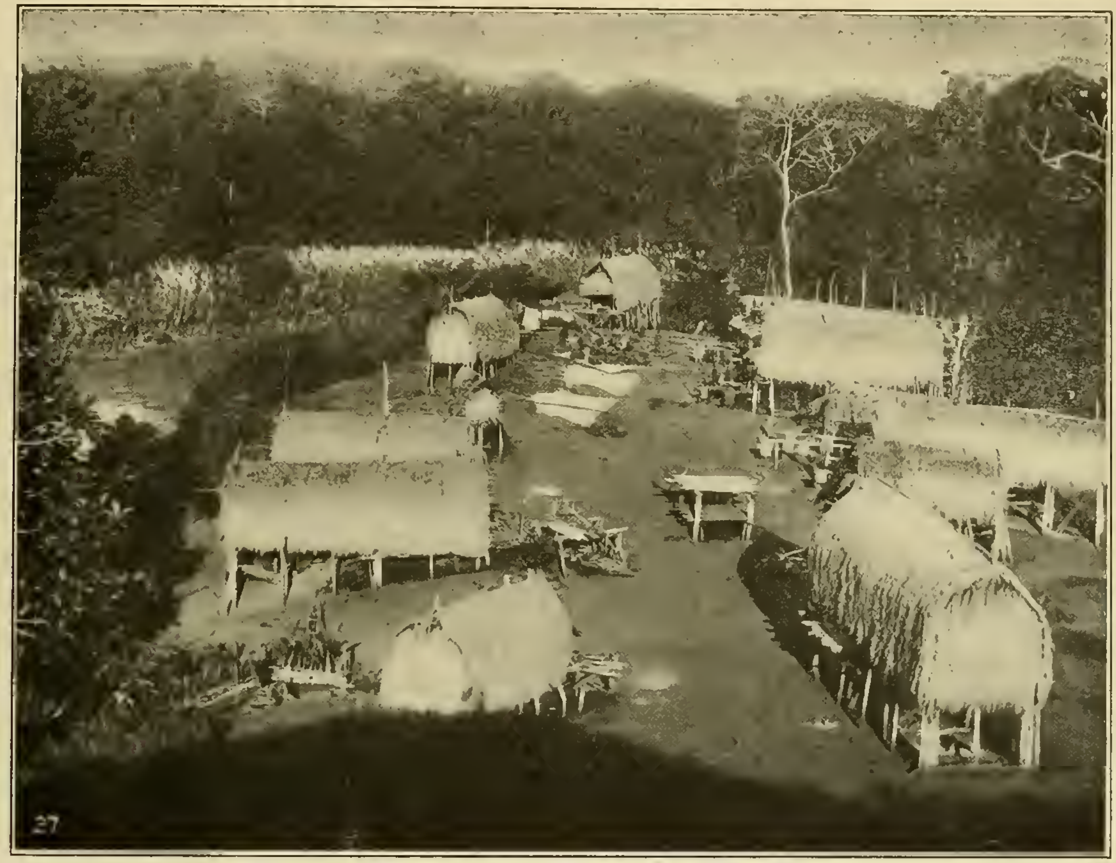


FIG. 44. NEW GUINEA VILLAGE.

Even if we knew all about the ways of construction, the materials used and the necessities governing the final result, this would not be the place to enlarge upon the subject which might fill volumes. We can only glance here and there, with the aid of photographs, of which there are many more at hand than there are memoranda of material or actual uses of the pictured dwellings, for almost all explorers of the present time go provided with cameras, and bring back good or at least interesting results, some of which I am still to present here. I will be as brief as possible, for I am impatient to come to my chief subject, the housebuilding of the old Hawaiians, and I have not the privilege of turning over the pages until I come to desired matter, as my readers have.

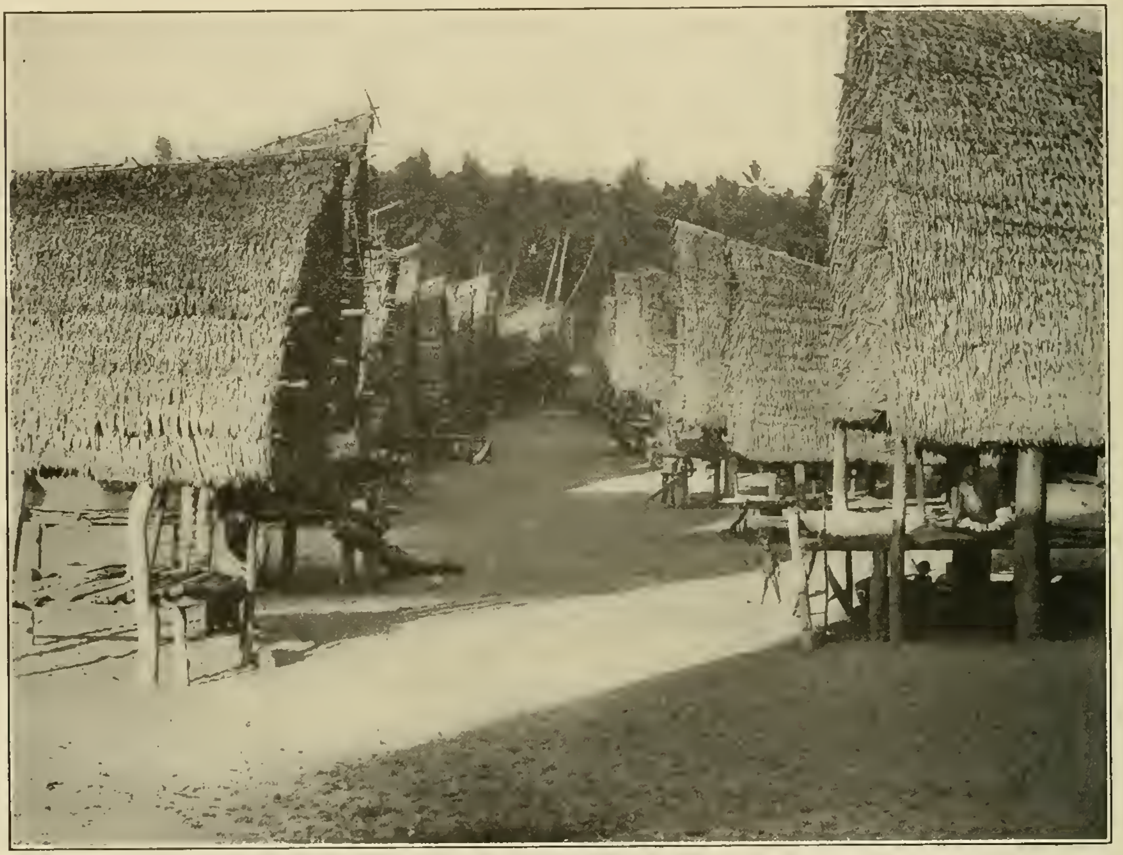


FIG. 45. A VILLAGE STREET IN NEW GUINEA.

First the pile dwellings: many have been the discussions as to the why of this very ancient method of establishing one's house, but it is fair to suppose that not one rule applied to all the races in widely separated parts of the earth, and whether it was protection from enemies, human or animal, or the more insidious but not less deadly forces arising from a marshy country, or merely convenience for a boating and fishing race, and for the scavenging needs of humanity, we care not now; we have merely to recount the fact and manner of these Pacific pile dwellings (which, as we shall see, are not confined to damp or watery regions).

There are many ancient voyages, especially among the Dutch, that give us accounts of the pile villages more or less distinct, but we may pass them by, for the men of New Guinea still build in many places precisely as did their remote ancestors. It is to be noted that as the scale of humanity descends many characteristics of what was once considered the peculiar property of animals, instinct, appear in human works; early habitations differed little for many generations, but resembled their archetype almost as clōsely as the cell of the honey bee in our modern hives resembles that of Hybla's honey-maker. I shall, however, quote from Dumont D'Urville,[32] who, three quarters of a century ago, gave his readers a glimpse of one of these villages on Geelvink Bay, off Dorei in the northwestern part of Dutch New Guinea:

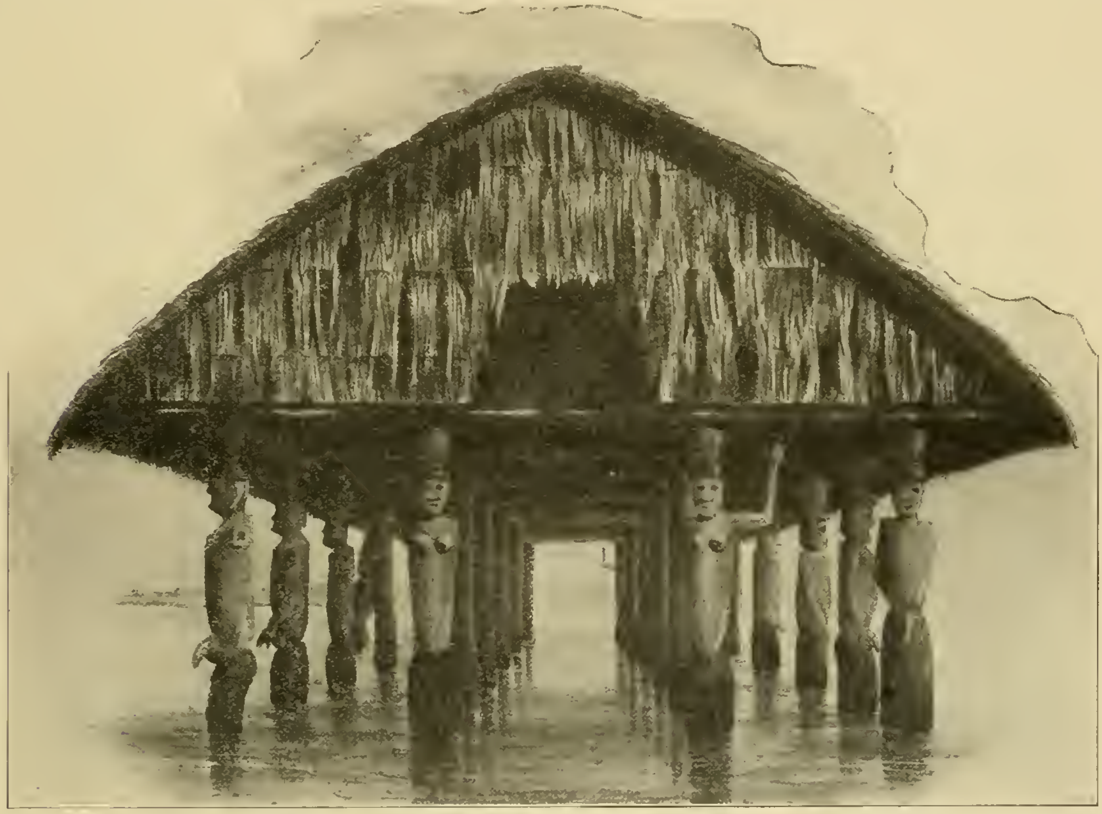


FIG. 46. SACRED HOUSE AT DOREI, D'URVILLE.

> Chaque village renferme de huit à quinze maisons établies sur des pieux : mais chaque maison se compose d'une rangée de cellules distinctes, et reçoit plusieurs familles : Quelques-unes de ces maisons contiennent une double rangée, de cellules séparées par une couloir que régue dans toute leur étendue. Ces édifices, entièrement construits en bois grossièrement travaillé sont percés de toutes parts à jour et braulent souvent sous les pas du voyageur.

---

[32] Voyage de la corvette L'Astrolabe exécuté par ordre du Roi pendant les années 1826–1829 sous le commandment de M. J. Dumont D'Urville, Capitaine de Vaisseau. Histoire du Voyage, Tome Quatrième p. 607. Paris, 1830-33.

This author also gives a remarkable plate of a sacred house at Dorei built on carved piles over the water, but gives no sufficient description. The portion of the plate showing the house is reproduced in Fig. 46. I am informed, however, by a recent traveler[33] that this house no longer exists.

I turn now to the opposite end of New Guinea, and quote as my authority a man who has done much to increase our knowledge, not only of that part of the great island geographically, but has intimately known the people whom he went to teach, Reverend J. Chalmers. I met Mr. Chalmers (Tamate, as the natives affectionately termed him) in Sydney a short time before his martyrdom at the hands of a cannibal tribe, who knew not their true friend, and I was much impressed with his modest sincerity and great knowledge of his people. He has written all too little, but in one of his later writings[34] we find:

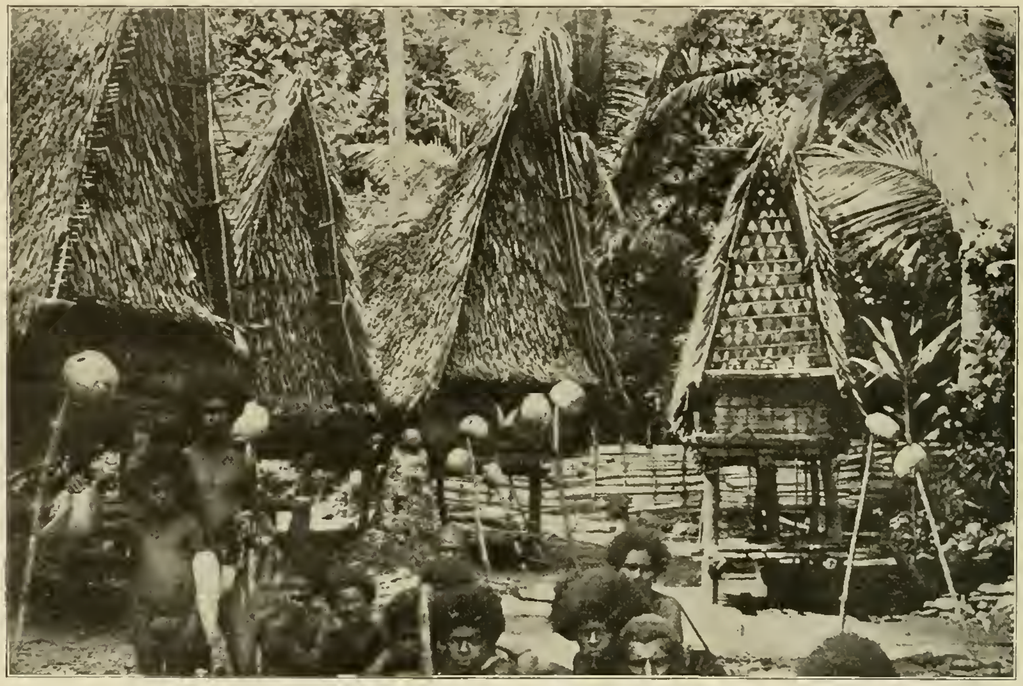


FIG. 47. VILLAGE ON DUAU.

> Early in the afternoon, after passing the river Vailala, we anchored at Kaili, twenty-two miles from Port Moresby, with 450 inhabitants. Kaili is charmingly situated at the head of a spacious bay. This is the second entirely marine village I have visited. It consists of fifty houses built on long poles in shallow water. There are four rows of these dwellings, the teacher's being the last. The church which stands apart between two rows, is connected with Reboama's [the teacher]. The road to church is merely one row of poles stuck in the sea, cross-sticks connecting the sacred edifice

---

[33] Mr. Thomas Barbour, who has made many important observations in that region.

[34] Work and Adventure in New Guinea. J. Chalmers and W. Wyatt Gill. London, 1885.

with the first row of aerial dwellings. It must be a ticklish thing to walk to church by such a road. There is no communication between the other rows except by canoes or swimming.

We entered one or two curious dwellings. Their valuables consisted of grass petticoats, armlets, spears, clubs, axes and nets, with a few earthenware pots for cooking. The only reason assigned for erecting these marine villages is fear of their inland foes, and that their fathers did so before them. The church, like all other dwellings at Kaili, is a frail construction of sticks, sides and roof thatched with sago palm leaf. It is spacious, but has neither pulpit nor seats. As we paced up and down inside, it gently swayed to and fro in the breeze. These sea-villages have one obvious advantage over those built ashore—they are free from mosquitoes.

Passing on our way eastward, we saw a number of old piles, indicating the original site of Kaili before they were driven away by the Manukolo. Later on we anchored at the village of Kapakapa, consisting in truth of two hamlets half a mile apart, thirty-three miles east of Port Moresby.

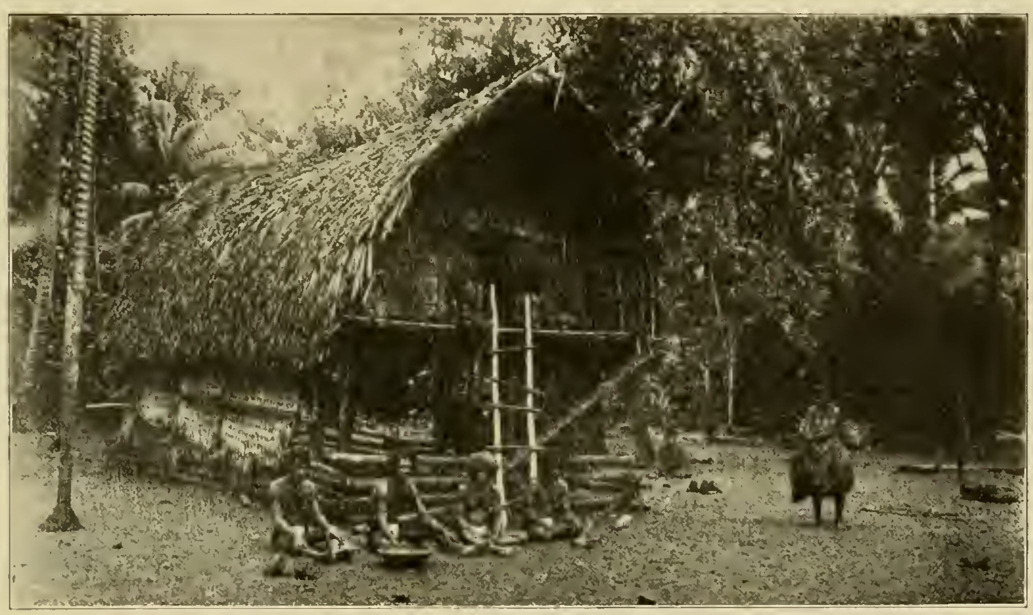


FIG. 48. HOUSE IN MILNE BAY.

This is my third Swiss-lake-like village in New Guinea. It has a population of 450. Ioane, a native of Savage Island (Niue), is their teacher. I was struck with a hut standing apart from all others in the middle of the bay, and learned that it was built by a man who had quarrelled with all his friends! Fowls and hogs are fed and evidently thrive, in these remarkable dwellings. Our boat was pulled between the rows of dwellings, Mr. Chalmers occasionally throwing a handful of small pieces of tobacco into the sea. Men, women and children all dived down for that coveted prize, and in a friendly way contended for it. After dark on the same eventful day, Captain Liljeblad succeeded in making Hula, a distance of fifty-two miles from Port Moresby.

Hula, like Tupuselei, Kaili, and Kapakapa, is built in the sea. It contains about 600 people. With our clerical friend I went in a canoe, through this long village, or rather two villages. Wishing to look at some of their houses, we climbed—not without some difficulty—up onto a platform ten feet above the sea. On this wretchedly insecure place they dance every night by torchlight. By day the younger members of the family sit and smoke there, regardless of the hot sun. Beyond is a shaded place for the parents. Climbing up a short ladder, you enter by a small door into their only sleeping apartment, which is very dark. A portion of it, however, is marked off; here the daily cooking is done, the accumulated ashes preventing the house from catching fire. The flooring is made from the sides of old canoes well adzed and secured to the framework of the house by rattan cane. One would surmise that their bones would be sore with lying through the night on bare boards: such, however, is not the case. Their ornaments and petticoats, weapons and chatties, hooks, lines and seines, are all in their proper places. The thatch is either of sago or nipa-palm leaf. All along, outside the ridging, sprouting cocoanuts are kept ready for use. Ornaments occasionally dangle from the extremity over the doorway. I noticed everywhere small oysters adhering to that part of the mangrove which is submerged: these become poisonous through contact with the mangrove.

Each dwelling in Hula is connected with the next by means of a single loose plank. A rail sometimes assists the hand in steadying the body of the adventurous traveller. It was interesting to observe how *they* ran from one house to another in perfect safety. We too achieved the feat, not, however, without fear of getting a ducking.[35] [Loc. cit., p. 281 et seq.]

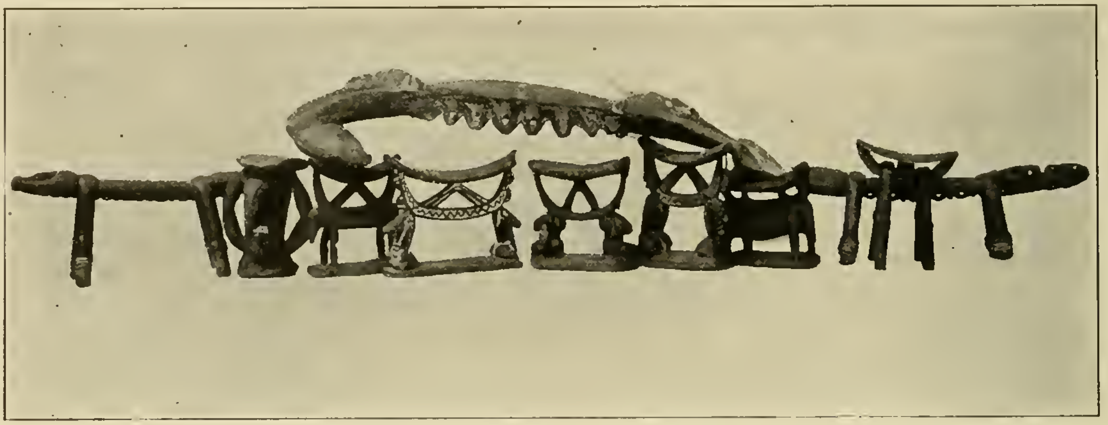


FIG. 49. NEW GUINEA PILLOWS.

Kerepunu is a magnificent place, and its people are very fine-looking. It is one large town of seven districts, with fine houses, all arranged in streets, crotons and other plants growing about, and cockatoos perching in front of nearly every house. [P. 40.]

The brief glimpse of Kerepunu, a village on the mainland, shows that the love of ornamentation, a strong trait of the Papuan race, there materialized in ornamental plants and birds, the former a difficult thing to manage about houses perched over the sea. The houses themselves, as everywhere in New Guinea, are still on piles. The tree houses, to which we shall come presently, are only built on gigantic, living piles. To return to our missionary leader who has sailed from the mainland some twenty miles to Wari (Teste of D'Urville) a small island where the natives make great use of human bone in their rather unpleasant ornamentation, and he thus describes their houses:

Their houses are built on poles, and are shaped like a canoe turned bottom upwards, others like one in the water. They ornament their houses on the outside with cocoanuts and shells. The

---

[35] I had a good photograph of one of these pile villages but it has been misplaced, and a friend who promised me others to replace it has not yet fulfilled his promise; so I must ask my reader to imagine one of the ordinary villages built on land but still on piles, to be in a season of flooding, for the construction of the houses is much the same.

> nabobs of the place had skulls on the posts of their houses, which they said belonged to the enemies they had killed and eaten. One skull was very much fractured; they told us it was done with a stone axe, and showed us how they used these weapons. [P. 42.]

All through the Pacific there is a close relationship between men and pigs, not merely social but religious. In Hawaii not only was the pig a domestic pet, frequently taking the child's place at the human mother's breast, but when the poor relics of humanity were placed on the altar as a sacrifice to the gods the pig almost invariably accompanied them, the order of immolation being first a layer of pigs, then of human bodies face downward, and a repetition of this until the pile was complete. In this group also the vicarious sacrifice for a man was a black pig, a white cock and a red fish. The connection was not confined to the Polynesian race, but was quite as strong among the darker-skinned races of the Great Ocean. In the Aroma district of New Guinea, Chalmers tells us:

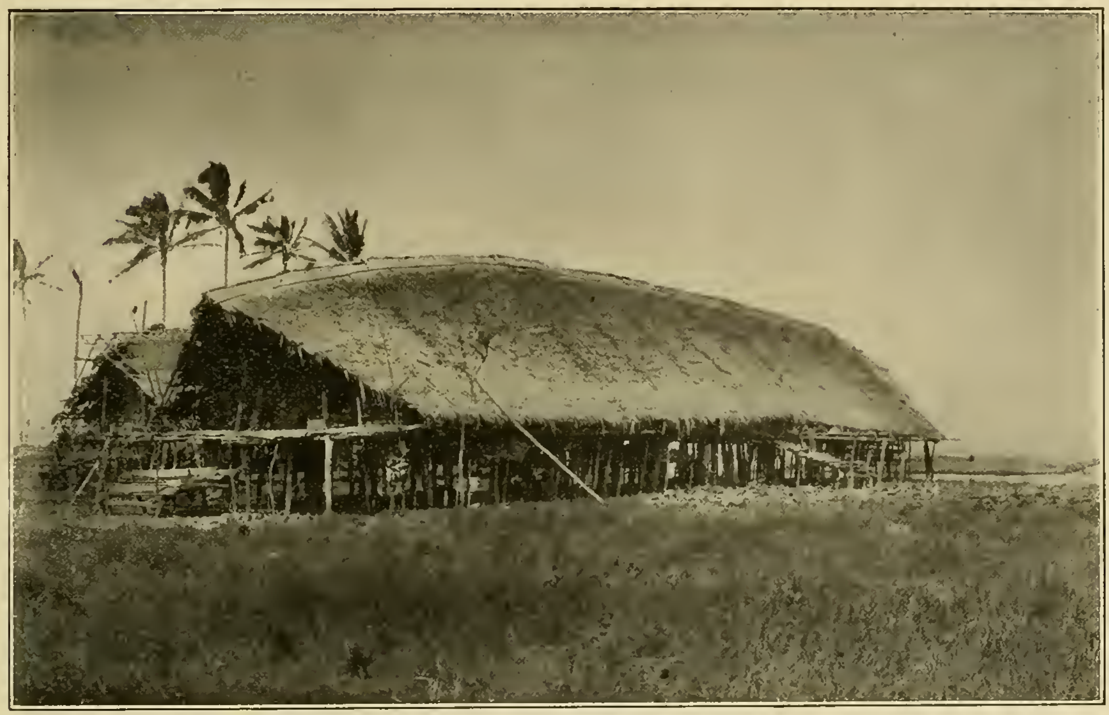


FIG. 50. LONG HOUSE IN NEW GUINEA.

> Pigs' skulls are kept and hung up in the house. Food for a feast, such as at house-building, is placed near the post where the skulls hang, and a prayer is said. When the centre post is put up, the spirits have wallaby, fish and bananas presented to them, and they are besought to keep that house always full of food, and that it may not fall when the wind is strong. [P. 84.]

Compare the centre-post of the Maori whare. From the same authority we read:

> When they go on trading expeditions, they present their food to the spirits at the centre-post of the house, and ask the spirits to go before them and prepare the people, so that the trading may be prosperous. [P. 85.]

The illustration of the village on Duau (Normanby Island of the D'Entrecasteaux group), Fig. 47, shows both the coconut decoration of these Papuan houses and also the human skulls, five of which appear on the horizontal bar across the gable of the house on the extreme right of the picture. It is probable that the coconuts are a modern substitute for skull, which they certainly resemble, and in some remote villages this substitute has not yet obtained. No worse, my readers, than the ancient customs on Temple Bar and many a city or castle gate in England! Generally trophies of conquest, in some places the skulls are the relics of dear relations. Chalmers tells of a widow who carried about with her in a small basket the skull of her dead husband, and as this husband had five wives, three inferior ones had the finger, toe, and other small bones drilled and strung as necklaces, while the fifth widow wore only his hair (p. 290). Different from the Hawaiian and Fijian who buried the bony relics, at least those connected with house consecration, here they are all above ground and in the light of day. The neat construction may be noted in the illustration. On piles, though not in the water, the ground plan is a narrow oblong and the roof is exceeding steep, out of all proportion to the walls of the house. The gable ends overhang the thatched walls which may be plain or decorated.

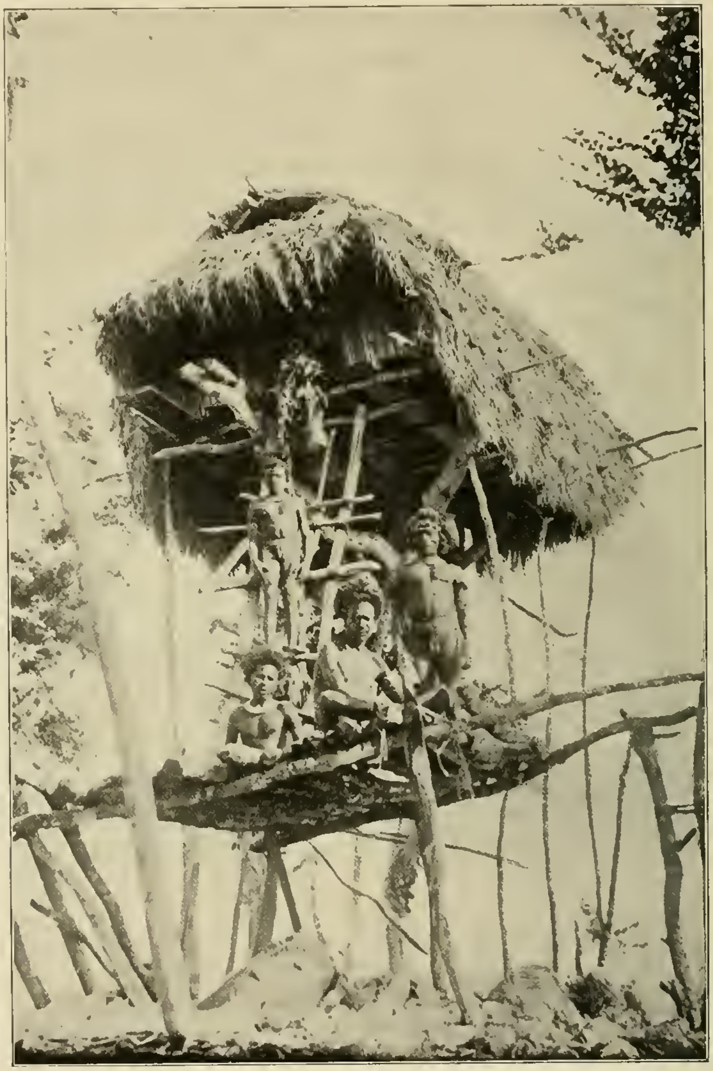


FIG. 51. A TREE HOUSE IN NEW GUINEA.

In the house in Milne Bay, shown in Fig. 48, the roof is more barrel-shaped, and covers a platform or verandah to which access is had both by a direct ladder and an inclined plank. The basement is fenced to keep out animals, and mostly closed in with mats. The household work is generally done out of doors, or in wet weather beneath the house, which, like the Hawaiian, serves mainly for sleeping purposes. We have given illustrations of the Samoan, Tongan and Fijian pillows, and it is well to give the fantastic forms affected by the Papuan of New Guinea, for these articles, as on the other groups mentioned, form with the sleeping mats one of the most universal and important portions of the house furniture, where the house is chiefly a sleeping apartment, and in New Guinea they curiously correspond with the fantastic designs of the houses. The animal form is everywhere noteworthy (Fig. 49), from the antediluvian reptile on the top of the row to the nondescript figure second from the left extreme. Like those already figured these pillows are for the neck and not the head, whose curious capillary dressing would be greatly disturbed by an ordinary pillow. Most of these pillows are from eastern New Guinea and the adjacent islands.

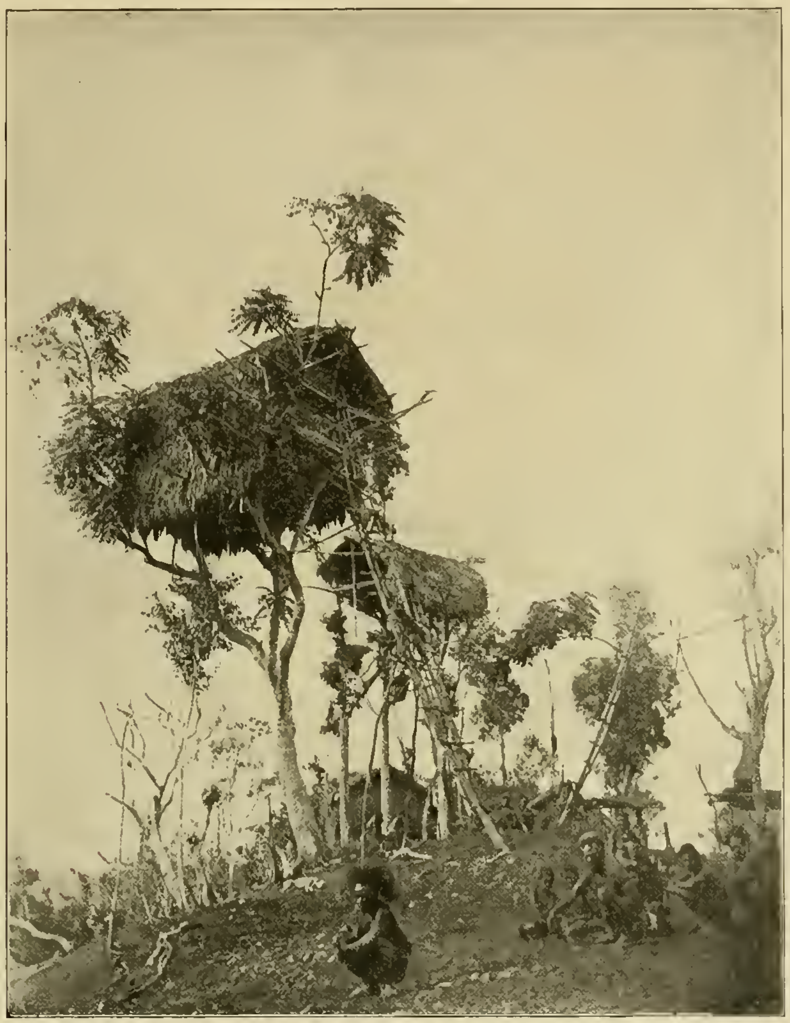


FIG. 52. TREE HOUSES IN NEW GUINEA.

Chalmers gives us so much information, often in unexpected places, that I am compelled to quote from him, picking up bits here and there. At Maiwa, on the Gulf of Papua:

> They have good large houses, kept wonderfully clean, with sleeping benches in all of them. In front of many of the houses are nicely kept flower gardens. The largest houses are built to represent an alligator with open mouth: the platform in front of the house is the lower jaw, and the long shade over the platform the upper, so that standing on the platform you stand in the alligator's mouth, the house sloping to appear as a body. One house, to be used as a temple in one of the inland vil-

lages, was about 150 feet long, very high, with carved posts, and in front overhead a beautifully decorated shade, with long pendants of different kinds of leaves. [P. 135.]

The centre post in every house is sacred to Kaevakuku, and her portion of food in every feast is first offered there. The first fruits belong to her. [P. 152.]

Their dwellings, as everywhere else in New Guinea, are built on piles about eight or ten feet above the ground. They are substantially built, but singularly arched. The house of each chief is furnished with a platform, about two feet from the ground, covered with a handsome cupola, but open at the sides, and floored with split bamboo. Here the men meet to discuss their tribal affairs. Between the houses are small enclosures of young areca palms, betel-pepper plants, variegated crotons, red cordylines and other shrubs. [P. 273.] The thatch used for the roof and sides of their houses is the leaf of the sago palm, which is not (as in Polynesia) sewn on to the small rafters, but pressed down firmly by long poles secured to the framework of the house. [P. 274.]

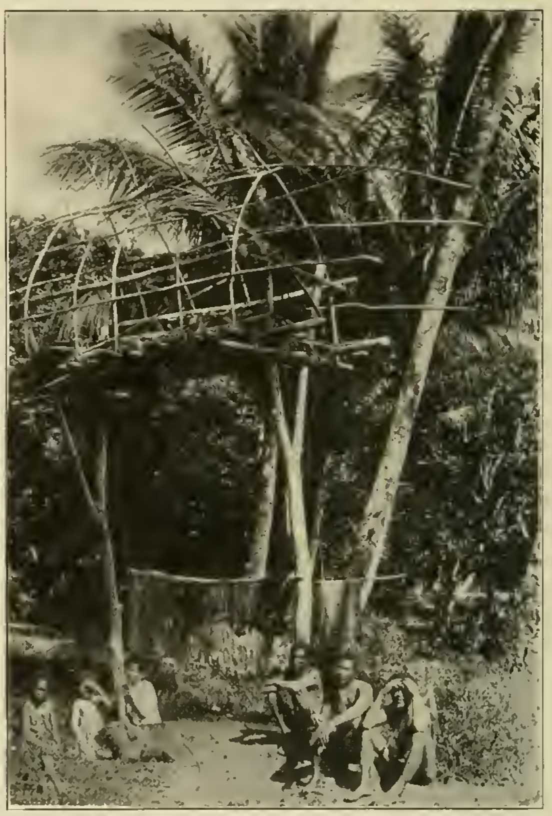


FIG. 53. CLUB HOUSE FOR YOUNG MEN.

From the dead piles to the living tree seems not a long step, and we find all along the New Guinea coast illustrations of this habitation. The one represented in Fig. 51 is not one of the highest, but shows the general construction better than any view that I have in my collection, and marks the transition from pile to tree. In this case the tree or trees, no longer living, serve merely to raise the house above the position of convenient attack; the house is well built and skilfully balanced on its supports, while the lower platform serves for a cooking place or a general rendezvous. The frame of a similar structure intended for a Dubu or club house for young men is shown in Fig. 53. In this case the elevated position of the building seems not so much for protection as for privacy.

I have referred to the communal house, common enough in this region, and a picture is given in Fig. 50. It is a long, barn-like structure, imposing by its size rather than by any grace of architecture. Perhaps the more common mode of entrance is at the ends, where the doors at either end are connected by a long passage from which the many apartments open on both sides. A family occupies one or more rooms, and the privacy is reasonably observed: each has its own hearth and provides its own food. I have not seen any statement as to the course pursued in building or keeping in repair this large habitation. Communal houses are common in the East Indies. See also, for the entrance, Plates XXIV and XXV.

Kiriwina Group.—The Kiriwina or Trobriand group lies southeast from New Guinea and seems in some measure a prolongation of the great island. In curious forms of dwellings it rivals New Guinea, although the population of the principal island, Kiriwina, is largely Polynesian. The houses, as may be seen in Figs. 54 and 55, are mostly roof. In the former illustration there is a little basement, slight vertical curve in the roof, and two end doors: while the whole gable end is of ornamental construction like those on Kusaie. So narrow is the house that, judging by the human figure in the foreground, a man could hardly lie across the floor. The gable of the house on the left shows the texture of the projecting roof, and there seems a distinct basement as well as an elevated platform. The whole scene has the effect of a stage setting. In the second illustration the horizontal curvature of the roof is well shown, as well as the careful ridge-covering. The gable ends seem imperforate and are not thatched, so that the house proper must be very dark and probably used only for bedroom, like most Polynesian houses. The house on the left seems to have a roomy but unoccupied basement, while that on the right has a distinct porch protected by a light roof. All the houses are placed in a close grove of coconuts which may partly account for their narrow ground plan. I cannot trace in the few photographs in my collection any connection with the general Polynesian house, but explorations are needed sorely in all this region to clear up the connection of the Polynesian inhabi-

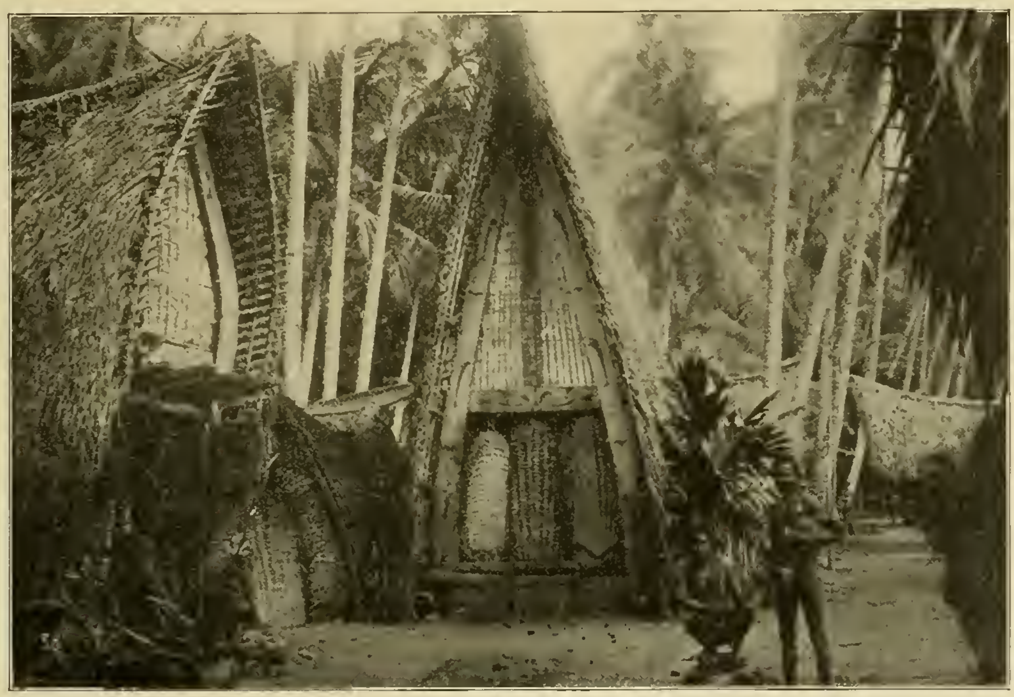


FIG. 54. HOUSE FRONT IN KIRIWINA.

tants, said to number many thousand, with their brethren to the eastward. It is too true that this entire archipelago has been strangely neglected by scientific explorers. As the two pictures which I present were taken in recent years, although I cannot fix the exact date, it is evident that modern and foreign changes have not made much headway, and doubtless much remains of the olden time.

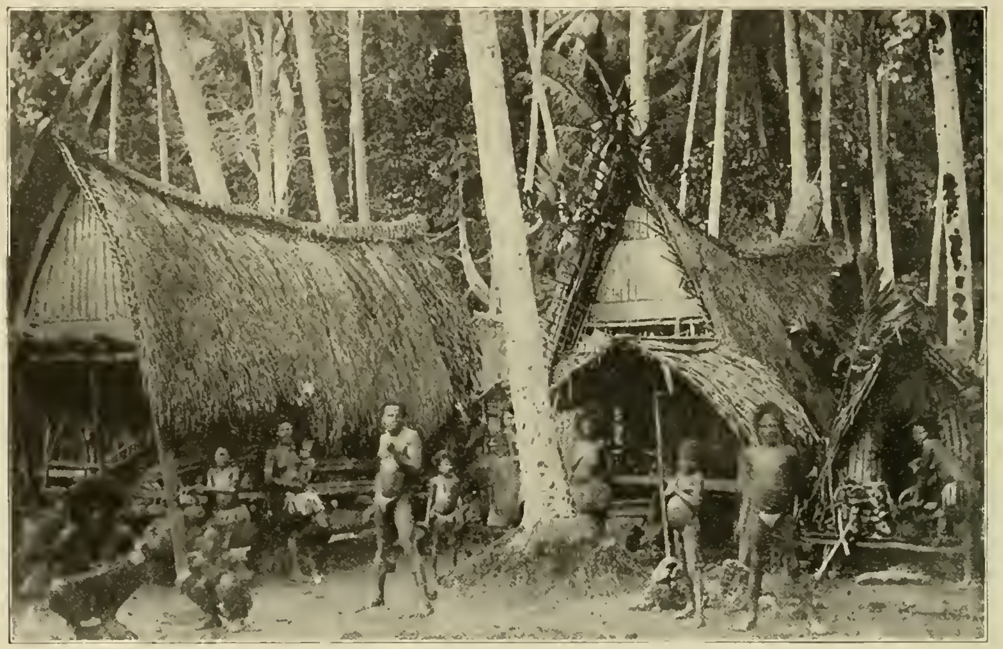


FIG. 55. A KIRIWINA VILLAGE.

New Hebrides.—Passing to another group of Papuan cannibals (for however much the missionaries have done to eradicate this great stumbling block to timid explorers, there are many left who enjoy a feast on their fellow men, not merely at their fellow men's expense) we have some very interesting records from the camera of the Reverend J. H. Lawrie, for some time a missionary in this region, through whose kind introduction to residents of the group I owe much of my information about the New Hebrideans and a collection of many of the least known objects of their manufacture. Three of the photographs of Mr. Lawrie, Figs. 56-58, show a low type of hut of the rudest construction (Fig. 56) hardly as neatly built as a skilled woodman would build his temporary camp. When, however, the fact that these people are very dirty is considered, the flimsy nature of their habitations, by no means so well built as most birds' nests, may be advantageous for a more ready purification by fire. As the people become more civilized and consequently cleaner, the house shares in the change (Fig. 57), and although the thatching is still rude, there is a greatly improved plaited reed front and definite doorway.

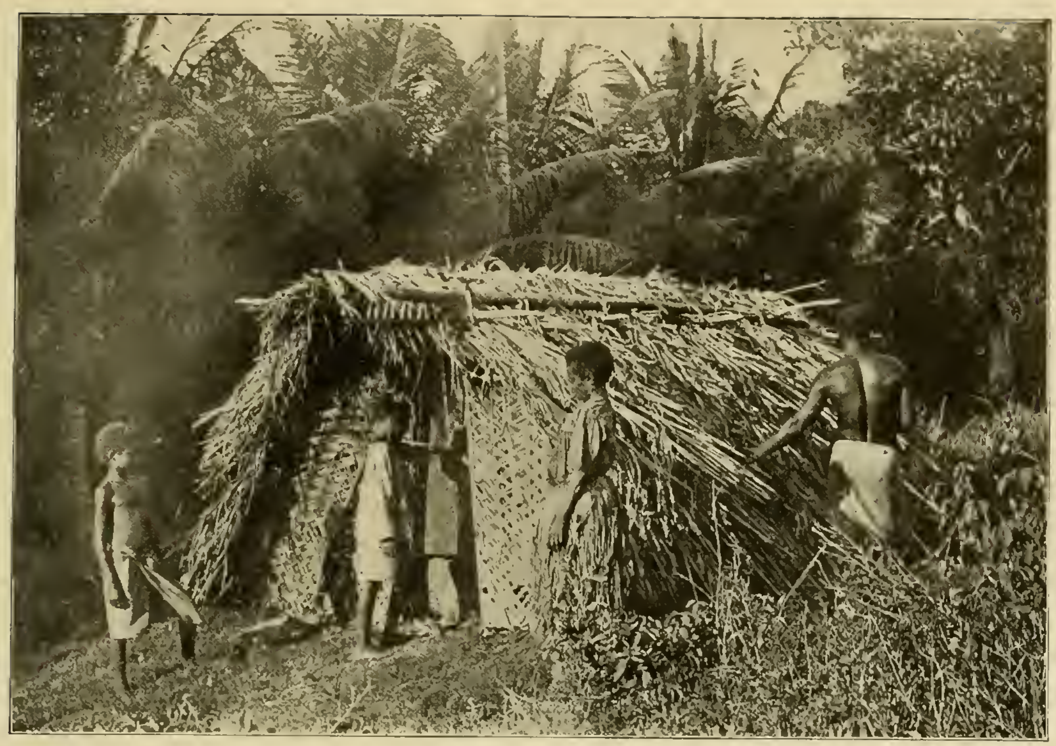


FIG. 56. ORIGINAL TYPE OF ANEITEUM HUT.

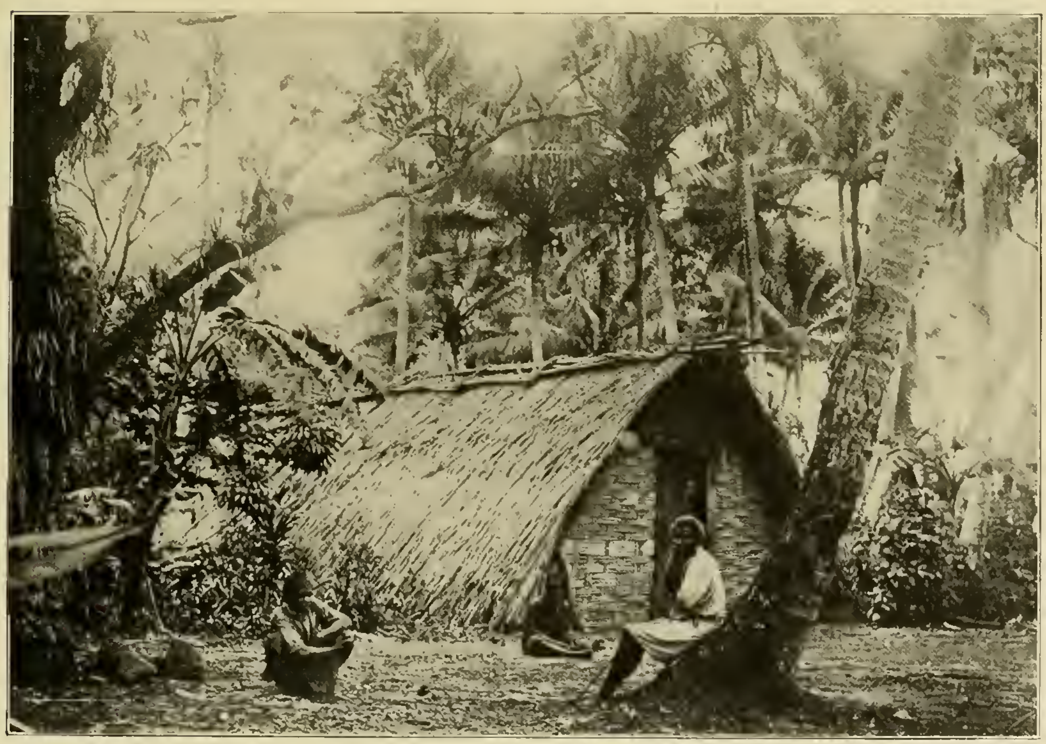


FIG. 57. ANEITEUM HUT WITH REED FRONT.

On the island of Malekula (Mallicolo) the form is very similar, and has a certain resemblance to the ruder of the Hawaiian grass houses. The people of this island are perhaps the worst cannibals in the New Hebrides, but their appetites do not seem to have improved their condition,—whether from the poor quality of their food, or their own insusceptible nature, cannot easily be determined. They are a people small in stature, light in bone, and with remarkably prognathous jaws, a low type. A little farther in the onset of foreign influences and the front is made of boards and utterly loses its native interest. This process of "amelioration" has already destroyed the houses of the aborigines and substituted throughout much of the Pacific region, nondescript sheds.

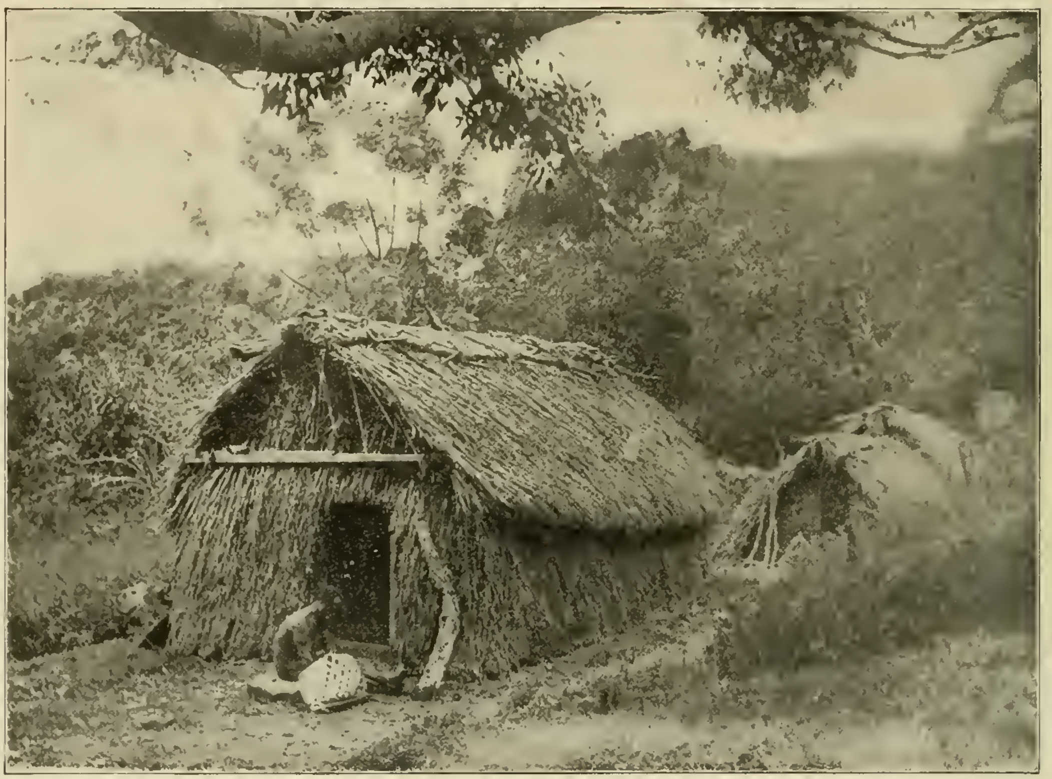


FIG. 58. VILLAGE IN MALEKULA.

The rude framing and coarse thatch are well shown in Mr. Lawrie's picture of house thatching on, I believe, the island of Tanna. The neighboring buildings look very modern, but there is no mistaking the native work, and primitive work, on the house in process of construction. Fig. 59.

When we consider that Nitendi, of the Santa Cruz group in the New Hebrides, was discovered by Mendaña in 1595, and was the seat of that miserable attempt at colonization where the same year the Spanish discoverer died, and for many years this archipelago has been a field for attempts at colonization by the French, it is surprising that so much still remains unaltered by grafted customs and fashions; that we have anything to call aboriginal. Plate XXIII shows two forms of rude hut on Santo.

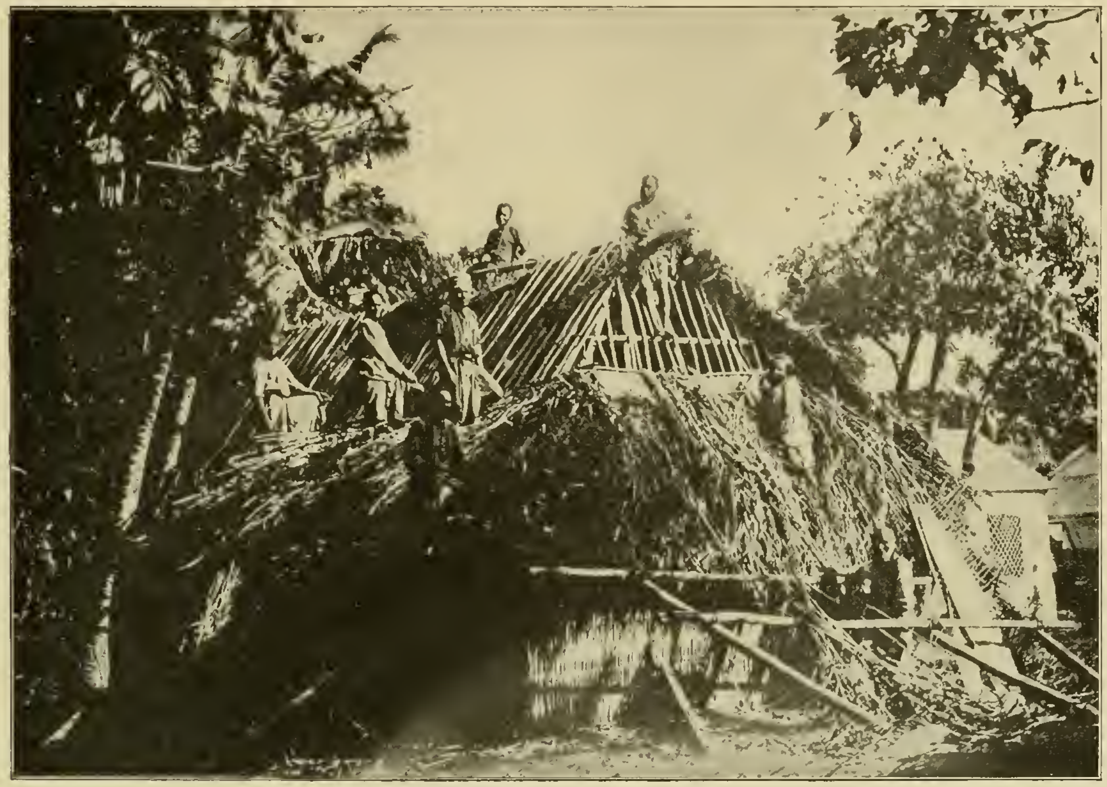


FIG. 59. THATCHING A HOUSE IN THE NEW HEBRIDES.

New Caledonia. — Passing for a moment the Solomon Islands, also a discovery of Mendaña on a previous voyage, we must notice the curious and divergent houses of the French colony of New Caledonia. In the voyage of D'Entrecasteaux in search of La Pérouse is the most detailed account of the houses of the New Caledonians, but the illustration is poor and the description too imperfect to show much more than that the modern habitations of these people are essentially the same that existed four generations ago: a circular hut with a conical roof without terminal ornament (see Cook, below), covered on both sides and roof with grass thatch, and with fairly high door, of which the jambs are often decorated with carving. Cook gives us the better account, in fact the best we have of the New Caledonian houses of the olden time, before foreign fashions had affected them (Second Voyage, II, 121):

Their houses, or at least most of them, are circular: something like a beehive, and full as close and warm. The entrance is by a small door, or long square hole, just big enough to admit a man bent double. The side walls are about four feet and a half high; but the roof is lofty, and peaked to a point at the top; above which is a post, or stick of wood, which is generally ornamented either with carving or shells or both. The framing is of small spars, reeds, etc., and both sides and roof are thick and close covered with thatch, made of coarse long grass. In the inside of the house are set up posts, to which cross spars are fastened, and platforms made, for the conveniency of laying anything on. Some houses have two floors, one above the other. The floor is laid with dry grass, and, here and there, mats are spread, for the principal people to sleep or sit on. In most of them we found two fire-places, and commonly a fire burning; and, as there was no vent for the smoke but by the door, the whole house was both smoky and hot, insomuch that we, who were not used to such an atmosphere, could hardly endure it a moment. * * In some respects their habitations are neat; for, besides the ornaments at top, I saw some with carved door-posts.

The two storeys recall the houses of the Gilbert Islanders, and it is unfortunate that Cook did not tell us more about the means of getting up stairs. Probably the close atmosphere made observations of the interior very difficult. The ornamented peak seems to have disappeared in the more modern houses, as similar shell decorations have gone out of fashion with the gables of the Fijians.

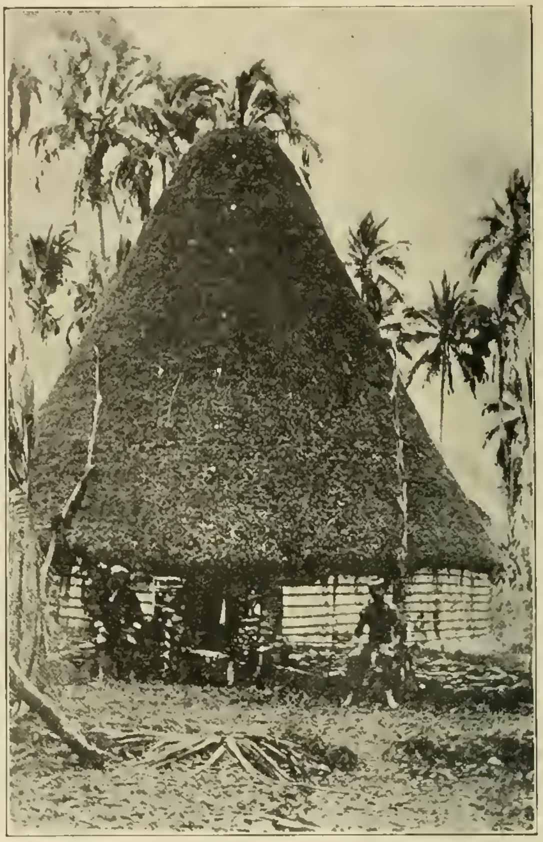


FIG. 60. NEW CALEDONIAN HOUSE.

Solomon Islands.—From Dr. Guppy, who had opportunities to make observations on many islands of the Solomon group, we take the following rather fragmentary account of the houses he found:[36]

The villages in the eastern islands of the group vary much in size. They usually contain between 25 and 40 houses, and between one and two hundred inhabitants. * * In the larger villages the houses are generally built in double rows with a common thoroughfare between; and the tambu house usually occupies a central positions. * * The usual dimensions of the dwelling-house are as follows: length 25 to 30 feet, breadth 15 to 20 feet, height 8 to 10 feet. The gable roof, which is made of a framework of bamboos thatched with the leaves of pandanus trees, or of cocoa-nut or areca palms, is supported on a central row of posts. The sides are low and made of the same materials as the roof. The only entrance is by an oblong aperture in the front of the building, which is removed 2½ to 3 feet above the ground, so that one has literally to dive into the interior, which from the absence of any other openings, is kept very dark. Such are the dimensions and mode of structure of an ordinary dwelling house in the eastern islands. The chiefs, however, have larger buildings, which in some instances * * * rival in size and in style the tambu-houses themselves. Many houses have a staging in front, which is on a level with the lower edge of the aperture that serves as the entrance. On this staging, protected by the projecting roof, the inmates are wont to sit and lie about during the day; and the men occasionally pass the night there. In the houses of the chiefs and principal men, there are generally spaces partitioned off for sleeping and containing a raised stage for the mats; but in the dwelling-house of an ordinary man no such partitions usually occur. Single men sleep on the ground on a mat, which may be nothing more than the leaves of two branches of the cocoa-nut palm rudely plaited together. Each man lays his mat by the side of a little smouldering wood-fire, which he endeavors to keep up during the night, and for this purpose he gets up at all hours to fan it into a flame.

---

[36] The Solomon Islands and Their Natives, by H. B. Guppy. London, 1887. p. 57.

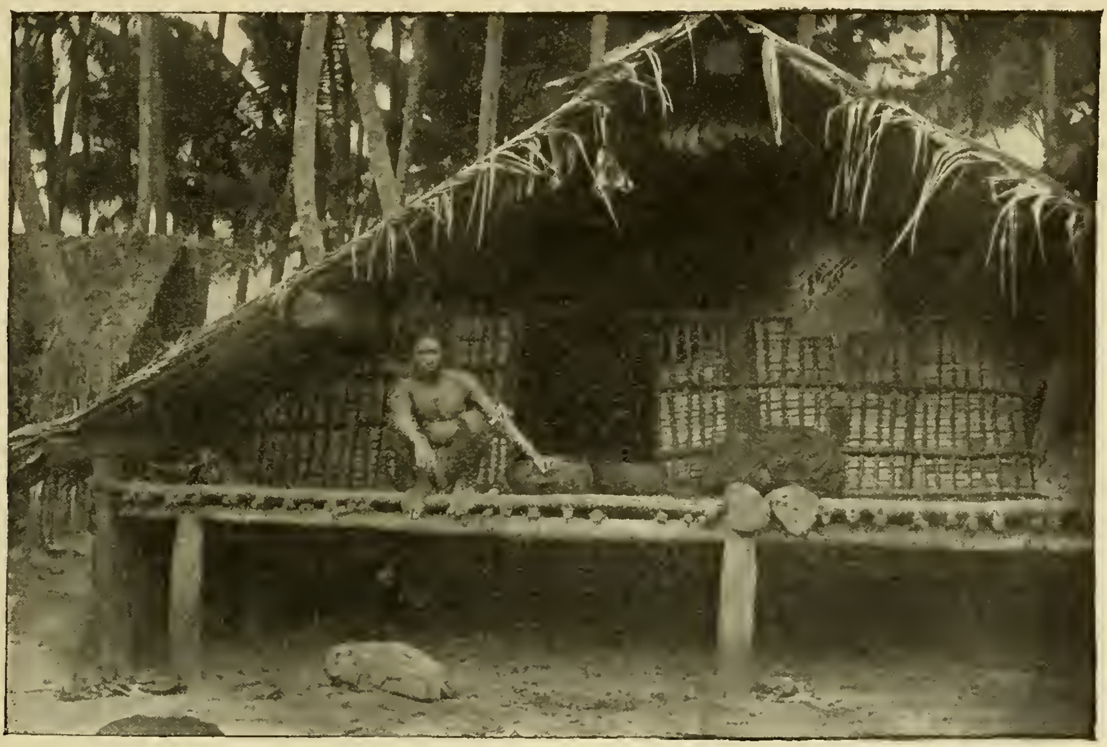


FIG. 61. SOLOMON ISLANDS HOUSE.

Of furniture there is but little except the large cooking-bowls, the mats, and a circle of cooking stones forming a rude hearth in the centre of the floor. I have seen in temporary sheds or "lean-tos", erected by fishing parties on the southern island of the "Three Sisters", fire-places formed of a circle two or three feet across of medium sized *Tridacna* shells, the enclosed space being strewn with small stones.

* * I am not aware how long a native house will last. The white residents, however, tell me that houses built for their own use, which are more substantial than the ordinary native dwellings, will stand some five or six years; and that, notwithstanding the heavy rainfall of this region, the thatch remains admirably waterproof.

* * In the villages of Treasury and the Shortlands, the houses are arranged in a long straggling row; and although close to the beach they are for the most part concealed by the trees from the view of those on board the ships in the anchorage. In the materials used, in their style, and in their general size, these houses resemble those of St. Christoval and the adjacent smaller islands. A thatch made of the leaves of the sago-palm or of the pandanus, covers the gable-roof and the framework of the walls. The usual dimensions of a dwelling-house are: length 25 to 30 feet, breadth 12 to 15 feet, height 10 to 12 feet. * * The residence of Mule, the Treasury chief, was one of the largest native edifices that I saw in the Solomon group. It is a gable-roofed building, measuring about 80 feet in length, 50 feet in breadth, and 25 to 30 feet in height. The front of the house which is at one of the ends of the building, has a singular appearance from the central part or body of the building, being advanced several feet beyond the sides, a style which is imitated in some of the smaller houses of the village. Its interior is very imperfectly lighted by small apertures in the walls. * *

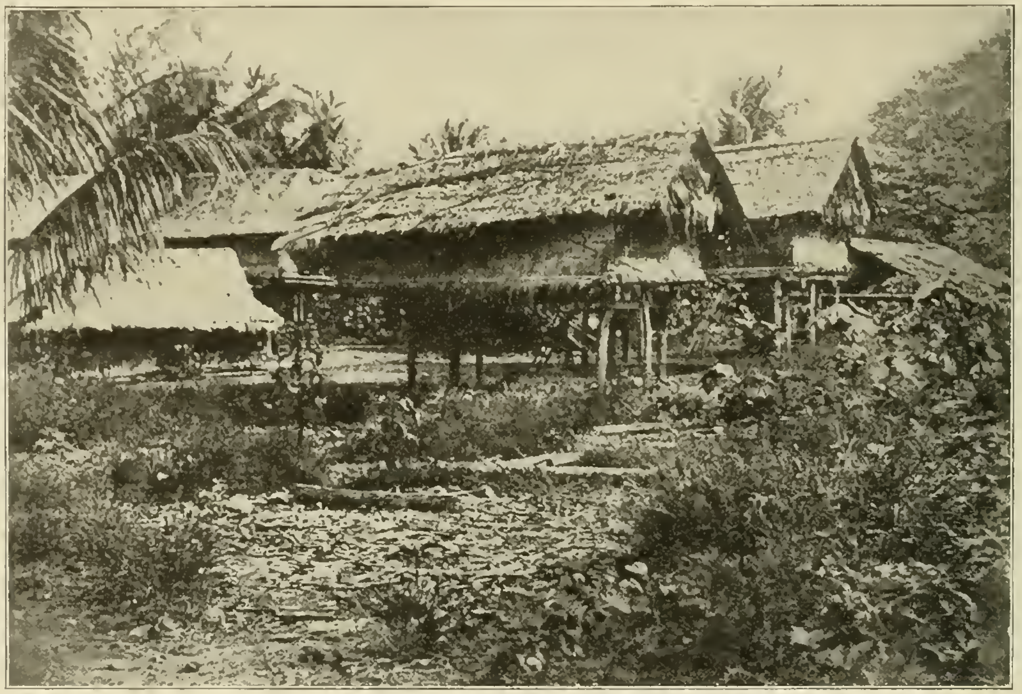


FIG. 62. PILE DWELLINGS IN FAURO ISLAND.

In the two principal villages of Faro, or Fauro, which are named Toma and Sinasoro, a number of the houses are built on piles and raised from 5 to 8 feet above the ground, as shown in the accompanying plate [Fig. 62]. But this custom is by no means universal in the same village, and depends, as far as I could learn, on the personal fancy of the owner. Both these villages are situated on low level tracts bordering the sea; but their sites are free from moist and swampy ground, to the existence of which one might have attributed this practice. The houses built on the ground are about 30 feet long, 20 feet wide, and 12 or 13 feet high; whilst those raised on piles are considerably smaller, measuring 22 by 15 feet in length and breadth, the building itself being supported on a framework of stout poles lashed on the tops of the piles by broad strips of rattan. These pile dwellings are reached by rudely constructed steps made after the style of our own ladders. The roofs of the houses in these villages have a higher pitch than I have observed in houses of the other islands of the Straits. Their eaves project considerably beyond the walls and the roof is often prolonged at the front end of the building forming a kind of portico. A neat thatch of the leaves of the sago-palm covers the sides and roof of each building.

With regard to the internal arrangements of the houses in this part of the Solomon group, but little remains to be said. In many houses a portion of a space is partitioned off for sleeping purposes, usually one of the corners; in others, again, the interior is divided into two halves by a cross partition. More attention is here paid to the comfort of repose than on the eastern islands. In the place of the single mat laid on the ground, they have low couches, raised a foot to eighteen inches above the floor, on which they lay their mats; whilst a round cylinder of wood serves them as a pillow. These couches, which the natives can improvise in the bush in a few minutes, are usually nothing more than a layer of stout poles, such as the slender trunks of the areca palms, resting at their ends on two logs.

In the Tambu-houses of St. Christoval and the adjoining islands we have a style of building on which all the mechanical skill of which the natives are possessed has been brought to bear. These sacred buildings have many and varied uses. Women are forbidden to enter their walls; and in some coast villages, as at Sapuna in the island of Santa Anna, where the tambu house overlooks the beach, women are not even permitted to cross the beach in front. The tambu houses of the coast villages are employed chiefly for keeping the war-canoes, each chief being allowed, as an honorable mark of his position, the privilege of there placing his own war-canoe; but in the inland villages, thes buildings are of course no longer employed for this purpose. Another use to which these buildings may be put is described on page 53, in connection with the tambu house of Sapuna in Santa Anna, in which are deposited, enclosed in the wooden figure of a shark, the skulls of ordinary men, and the entire bodies of the chiefs.

The front of the tambu-house in his native village is, for the Solomon Islander, a common place of resort, more especially toward the close of the afternoon. There he meets his fellows and listens to the news of his own little world; and it is to this spot that any native who may be a stranger to the village first directs his steps, and on arriving states his errand or particular business. In my numerous excursions, when thirsty or tired, I always used to follow the native custom in this matter, being always treated hospitably and never with any rudeness. The interior of these buildings is free to any man to lie down in and sleep. On one occasion, when passing a night in an inland village of St. Christoval, I slept in the tambu-house, the only white man amongst a dozen natives. Bloodshed, I believe, rarely occurs in these buildings; and they are for this reason viewed somewhat in the light of a sanctuary.

And now we come to the connecting link, a gruesome one, that binds the builders of important, not alone sacred, houses throughout the Pacific, from Hawaii to New Zealand, from Fiji to the Solomons—the human sacrifice. And again the bond between the man, at least the savage man, and the pig already referred to. Returning to our author we read:

The completion of a new tambu-house is always an occasion of a festival in a village. The festival is often accompanied by the sacrifice of human life; and the leg and arm bones of the victim may be sometimes seen suspended to the roof overhead. In the tambu-house of the village of Makia, on the east coast of Uji, I observed hanging from the roof the two temporal bones, the right femur and the left humerus of the victim who had been killed and eaten at the opening of the building; and similarly suspended in the tambu-house of the hill-village of Lawa on the north side of St. Christoval, in which I passed the night, I noticed over my head as I lay on my mat the left femur, tibia and fibula, and the left humerus of the unfortunate man who had been killed and eaten on the completion of the building twelve months before. At these feasts there is a great slaughter of pigs that have been confined for some previous time in an enclosure of strong wooden stakes, which may be allowed to remain long after the occasion for its use has passed away. After the feast the lower jaws of all the pigs consumed are hung in rows from the roof of the building. In one tambu-house I remember counting as many as sixty jaws thus strung up.

The style of building and the size and relative dimensions of the tambu-houses are very similar in all the coast villages of the eastern islands, a correspondence which may be explained from the necessity of the structure being long enough to hold the large war-canoes. As a type of these buildings, I will describe somewhat in detail the tambu-house of the large village of Wano, on the north coast of St. Christoval. Its length is about 60 feet and its breadth between 20 and 25 feet. The gable roof is supported by five rows of posts, the height of the central row being some 14 or 15 feet from the ground, whilst on account of its high pitch the two outer lateral rows of posts are only 3 or 4 feet high. The principal weight of the roof is borne by the central and two next rows, each of which supports a long, bulky ridge-pole. The two outer lateral rows of posts are much smaller and support much lighter ridge-poles. In each row there are four posts, two in the middle and one at each gable-end. These posts, more particularly those of the central row, are grotesquely carved, and evidently by no unskilled hand, the lower part representing the body of a shark with its head upwards and mouth agape, supporting in various postures a rude immitation of the human figure, which formed the upper part of the post. In one instance, a man was represented seated on the upper lip or snout of the shark, with his legs dangling in its mouth, and wearing a hat on his head, the crown of which supported the ridge-pole. In another case the man was inverted, and whilst the soles of his feet supported the ridge pole, his head and chest were resting in the mouth of the shark. * * * The roof of the Wano tambu-house is formed of a framework of bamboo poles covered with palm-leaf thatch, the poles being of equal size, whether serving as rafters or cross-battens, the latter affording attachment for the thatch. The same materials are used in the sides of the building. With reference to tambu-houses generally in this part of the group, I would remark that they are open at both ends, with usually a staging at the front end raised about four feet from the ground, which may be aptly termed "the village lounge". The tambu-house of the interesting little island of Santa Catalina or Orika—the Yoriki of the Admiralty chart—is worthy of a few specia remarks. Its dimensions are similar to those of like buildings in this part of the group, the length being between 60 and 70 feet. Placed in front of each of its ends are three circles of large wooden posts driven into the earth, each circle of posts being 4 or 5 feet in height and enclosing a space of ground a few feet across, into which are thrown cocoa-nuts and other articles of food to appease the hunger of the presiding deity or devil-god. The ridge-poles and posts are painted with numerous representations in outline of war-canoes and fishing parties, of natives in full fighting equipment, of sharks, and of the devil-god himself, with a long, lank body and a tail besides. * * * Some of the representations on the ridge-poles were of an obscene character. The central row of posts were defaced by chipping, which I was informed was a token of mourning for the late chief of the island, who had died not many months before.

The deification of the shark again is a link binding all the islands together, and it is not surprising that people whose daily food is taken largely from a tropical sea, and who must often have encountered these predaceous fish should have sought to in some way propitiate them. I will not stop here to discuss the fact that the people of some groups while recognizing the divinity of some sharks (as on Hawaii) still pursued the fish as legitimate game,—indeed it was the only game the Hawaiian chiefs had to tax their courage and skill. On the Solomon Islands the shark god had better treatment, as is shown by the carved representations of him and the use of his image to preserve the remains of the dead chiefs.[37]

I hope that this description of the uses of the tambu-houses will explain why I have referred to them so fully, for they are really the "living room" of the male portion of the population, as well as their guest chamber or parlor. The wet climate of these islands would make the raised platforms, which are the lounging places in the eastern Pacific, and the lightly roofed gathering places in the central region, useless the greater part of the year.

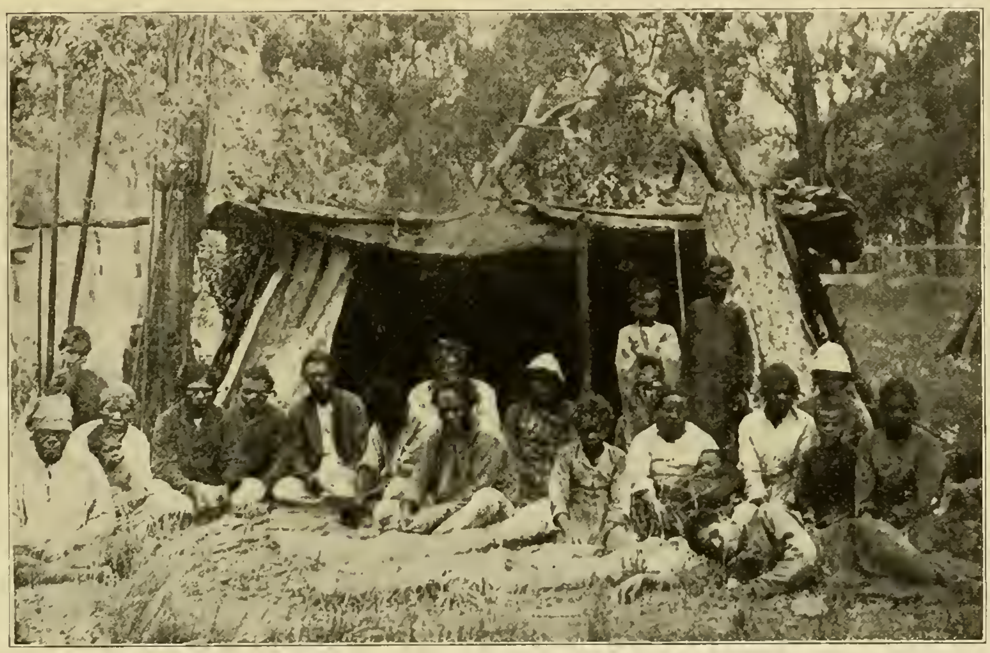


FIG. 63. AN AUSTRALIAN HUT.

Australian Houses.—We seem to have reached the bottom in the Pacific scale of civilization when we come to the work of the Australian Blacks in house building. A couple of forked sticks set up eight or ten feet apart with a ridge pole between the crotches is all the frame, and the stringy-bark tree furnishes the rest in the shape of great sheets of bark skilfully removed and laid against the frame in such direction as to ward off rain or wind. In reaching a new camp it takes but little time to build the wooden tent. A few handfuls of grass or leaves make a lair little, if any, better than a wild animal would scrape together.

Some of the explorers of Australia found something better than this general type of bark hut: Sir Thomas Mitchell in exploring the Gydir region found huts tastefully distributed, over-shaded by the flowering wattle, each dwelling semicircular or circular, the roof conical, and from one side a flat roof or portico supported on two posts extended; these were covered with reeds, grass or boughs. Péron found partly subterranean houses, and others have found framed structures. The more common type, however, was the bark-covered hut which best suited the nomadic life of the people.

---

[37] On all the groups that I have knowledge of the sacred nature of the shark does not prevent the use of his dried skin for drum-heads as on Hawaii, or for files or rasps as on the Gilbert Islands and elsewhere.

I hope that one thing has appealed to my readers as it has to me,—the never wearisome simplicity of even the rudest shanty built by the Australian blacks. Never a touch of the commonplace in their villages such as is overwhelming in most of our American towns where the house is sufficiently durable, comfortable for its inmates, and an ample protection from the weather, but utterly devoid of the picturesque. A row, perhaps, of stiff, unlovely cottages each a duplicate of the others, built by contract to make as much show with as little money as possible; the picture is familiar enough in the suburbs of most cities. Hardly more pleasing if more imposing, are the blocks of brick or stone,—even if the stone be a veneer of costly marble,—that line street after street of every large city.

In the Pacific islands most villages seem delightfully diversified: there is little pretentiousness in each house, the grouping among the trees or along the shore is often what no real artist could improve. True, to the practical being of many artificial wants, from a civilized city, the one-roomed shelter would hardly seem a proper stable for horses or odormobile, but to the islanders the almost empty space is pervaded by that most useful of furniture, contentment, and then the house is fully furnished.

The ephemeral nature of the stick and thatch building is typical of the village also, for the frequent wars are generally followed by the destruction of the town of the vanquished, and the remnant of the tribe builds elsewhere rather than clear up the ruins. Or, it may be, a war-vessel of some Christian nation comes among the islands and for some wrong, real or fancied, shells the town. Again some tribes desert the house in which the owner dies, and in which he may be buried. It is not surprising that the *home* sentiment hardly exists under these circumstances. While in Australia the tribes were nomads the limited extent of the Pacific islands confine the wanderings of the people to narrow bounds, and a greater change of abode can only be by emigration, and legendary history tells us this has again and again taken place, as when the Maori went from Hawaiki to Te ika a Maui as their congenors the Moriori had done long before.

Even the old Hawaiian village in spite of the likeness of its houses to hayricks, and its frequently bare exposure, had a fitness to its surroundings, it was never a blot on the landscape. The only complete Hawaiian village I have ever seen was in the valley of Kalalau on the island of Kauai. Remote and difficult af access, it remained uncontaminated by foreign fashions until a few years ago when the attractions of city life drew its few remaining inhabitants to Honolulu, and the frail houses fast perished. It perished, however, a true and unchanged Hawaiian village whose kind will never again be seen in the valleys of these islands. Let us now study these departed houses of the old Hawaiian, gathering from those who saw and described them in the earlier part of the last century what they can tell us and filling out the account as well as may be with the results of personal observation.

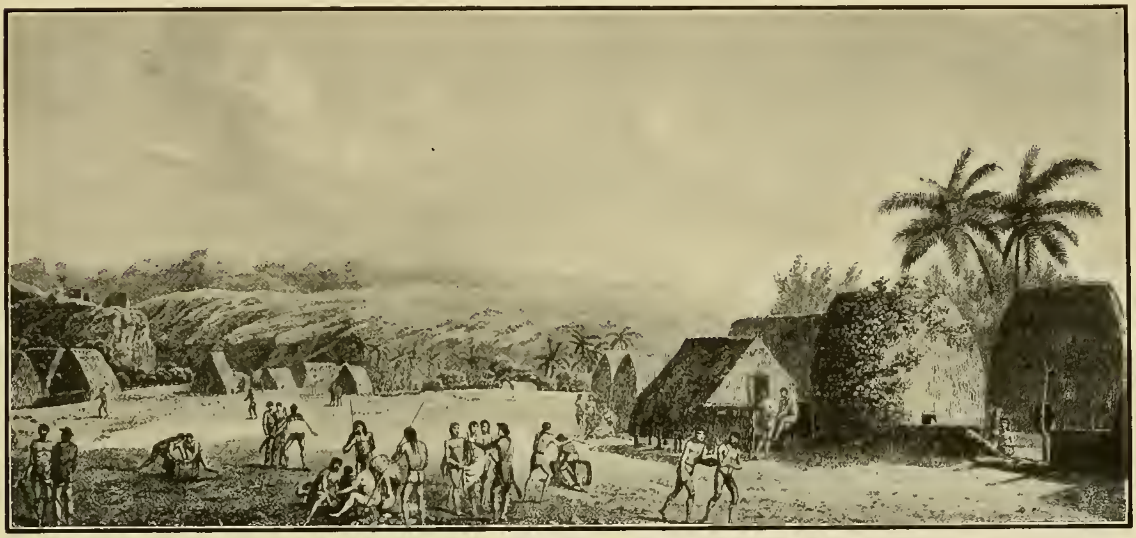


FIG. 64. VIEW MADE ON KAUAI BY COOK'S ARTIST WEBER.

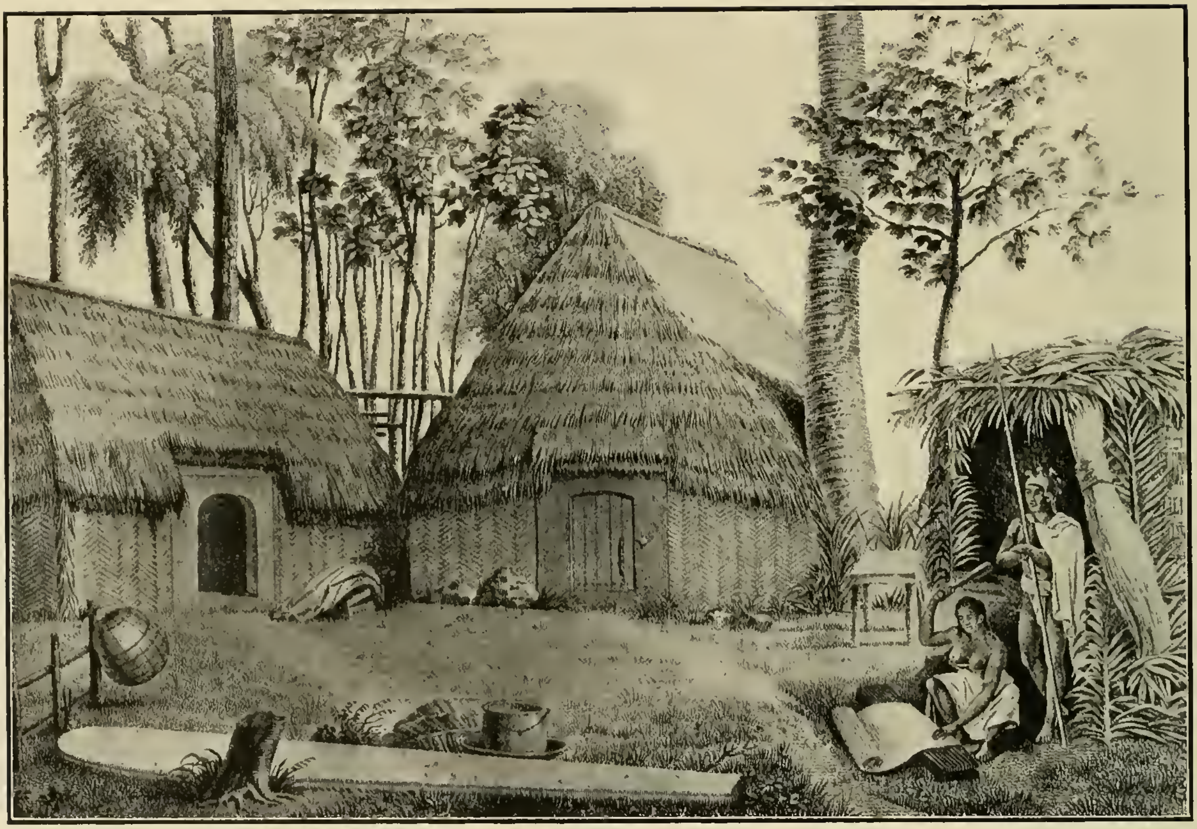


FIG. 65. HOUSES OF KALAIMOKU IN HONOLULU.

The House in Hawaii.

The Hawaiians were no exception to the general rule that primitive peoples in a mountainous country make their dwelling in caves to some extent. In this group the volcanic mountains offer many facilities to the troglodyte; for the innumerable lava streams that have coursed down their slopes abound in bubbles and conduits often of great extent, and while the superficial streams are so porous as to allow the rains to percolate through their whole mass, the subjacent ones are often more compact and contain dry chambers made accessible on the valley slopes by the erosion of ages, so that there are few, if any, mountain gorges without caves. From abodes of the living they have generally become the last resting place of the dead, and being for that reason carefully sealed up and concealed, are not noticed.

In time of war,—and in the old days that was nearly all the time on some part or other of the group,—caves were the refuge of the old people and children, and the Hawaiian annals, like those of more civilized warring nations, are stained with terrible massacres of such refugees by means of fires at the cave mouth. Some of these caves of refuge extended from the village to the sea like the well-known one at Kailua, Hawaii; others reach a long distance up the mountain slope and have several entrances. Molokai, the often used battle ground of the chiefs of Oahu and Maui, was noted for its cavernous hiding places, and legend tells of many caves where umekes, arms and other native treasures are still hidden, the kahu or keepers all silent in death. In the solitary valley of Moanui are said to sleep the ancient *Moi* of Molokai, each laid in his canoe as our Norse ancestors were laid in the long ship before the barrow was piled above it. Landslides have quite covered the mouth of these royal sepulchres, and only an earthquake more potent than is common on the group is likely to reveal their secrets.

More habitable than common caves were those large lava bubbles where the roof has fallen in admitting the daylight and air, and such still offer a comfortable camping place as the author has many times found in his explorations, and as lately as in the sixties of the last century, they were used in Puna by the mat makers. They were cool and, lighted by the open roof, had the agreeable effect of the Pantheon at Rome with its hypæthral dome.

Not a few of these open caves contain markings on the walls[38] and other indications of former inhabitants, but at present none is in use save for burial, and these may be more fully described in the chapter on Hawaiian methods of disposing of the dead.[39]

---

[38] I trust that these curious markings or figures which are found all over the group, even beneath present high water mark, will be fully described and illustrated by Mr. John F. G. Stokes who has given them much study.

The early houses, confining that word to superterrene structures, were doubtless rude tabernacles of branches (*hale kamala*) that reappear in the temporary structures of camping parties of the present day in the Hawaiian wilds. Unluckily palm leaves were not abundant[40] as in the East Indies and the Western Pacific, and most other leaves in drying cease to shelter. Native banana served as temporary shingles and the tough leaves of the ki (*Cordyline terminalis*) when properly applied were somewhat more durable. It is not difficult to imagine these poor dwellings of the early inhabitants, although neither record nor picture remains, but the house into which they developed in the increasing leisure and desire for comfort, we have more knowledge of, and will attempt to describe, although in the advance of foreign invasion even these have nearly passed, and the few that remain are looked upon as curiosities. Forty years ago Honolulu was well dotted with these thatched houses, as has already been mentioned, but when we look to the only native annalist, whose work dates some thirty years farther back, we shall perhaps be surprised at the little he knows about Hawaiian house building, or at least deems worthy of mention. There have been made several translations of the Chronicle of David Malo,[41] but it is best to give here the original with a literal translation of his description of the house:—

MOKUNA XXXIII.—NO NA HALE, ME NA MEA AI ME KA HOOMANA.

1. O ka hale kekahi mea nui e pono ai ko ke kanaka noho ana ma keia ola ana a me ka wahine, me na keiki, me na makamaka, me na mea e ae e hookipa ai.

2. He mea maikai ka hale, he mehana, he mea pale aku i ka ua, a me ke anu, a me ka la, a me ka wela. Ua noho nui no nae kehahi poe lapuwale ma na hale pono ole me ka manao he hale pono ia.

3. O ke ana ka hale o kekahi poe, o ka lua ko kahi poe, o ka loupali ko kahi poe, he puha laau ko kahi poe, he hale kamala ko kahi poe.

CHAPTER XXXIII.—CONCERNING HOUSES, THEIR FURNISHING AND DEDICATION.

1. The house was an important and good thing for a man's residence and health with his wife and children, his friends and those who enjoyed his hospitality.

2. A good thing was the house for warmth and a shelter from rain and cold, daylight and heat. Many were the foolish people who lived in wretched houses but thought them good enough.

3. A cave was the house of some folk, a pit of others, a sheltering cliff, a hollow tree of some, of others a shanty. Some attached themselves

---

[39] A plan of such a cave has, however, been given on page 166 of the present volume in illustration of the hiding place of a choice lot of old Hawaiian carvings.

[40] There were only three species of palm, the Coconut, brought probably by the early immigrants and never very abundant, and two species of the Loulu (*Pritchardia gaudichaudii* and *P. martii*), the latter fan palms and not so suited for constructive purposes as the pinnate fronds of the coconut. It has been suggested that the coconuts might have drifted here, but the currents that bring pine logs from the northwest coast of America surely would not bring coconuts.

[41] The latest, by Dr. N. B. Emerson, was printed by the Trustees of this Museum in 1903.

O ka hoopili wale aku malalo o ka poe mea hale kekahi, ua kapaia ko lakou inoa he o keia pili mai, a he unu pehi iole. O ke ano o keia mau inoa, he lapuwale aka. Aole pela ka noho ana o ka poe lapuwale ole, e hana no lakou i hale penei e hana ai.

4. E pii aku no ma ka nahelehele me ke koi a kua i na laau a pau a lawe mai o ka pou na laau pokole, o ke oa na laau loihi, o na pou hana he kiekie laua e like me ke kiekie o ka hale a ke kanaka i manao ai, pela ke kiekie o oia mau laau.

5. O na kukuna ma na aoao o ka hana, he haahaa iho ia, o ke kaupaku, he laau loihi ia e like me ka loihi o ka hale ana i manao ai, pela no ke kaupaku o kuaiole, he laau ia maluna iho o ke kaupaku; o na halakea oia na kia e ku ana maloko o ka hale; o ka aho he laau liilii ia; pau na laau o ka hale.

6. Eia kekahi, a auwahaia na pou a pau, he auwae ma ke alo o ka pou he wahi oioi ma ke kua o ka pou e ku ana iluna pela no na oa e hana ai, he auwae ma ke alo o ke oa, he manamana ke kua o ke oa, i wahi e komo ai ka mea oioi maluna o ka pou i paa, a pau alaila, e kukulu ia ka hale penei e kukulu ai.

7. E kukulu, mua ia na pou kihi, a paa ia mau pou, alaila kauia ke kaula, mai kela pou a keia pou, maluna kahi kaula, malalo kahi kaula, a ike ia ke kaulike o na pou kela pou, keia pou.

8. Alaila, e aua ia ka wa mawaena o kela pou keia pou a i keia ka likepu, alaila, kukuluia na pou a pau oia aoao, a paa ia poe pou, alaila, kukuluia kekahi aoao, a paa ia poe pou, alaila, kauia ka lohelau ma ka waha o ka pou, mai kela pou kihi a keia pou kihi.

9. Alaila, hoaia ka pou me ka lohelau; a pau ia, alaila, kukuluia na pou hana, a paa ia, kauia ke kaupaku a paa ia i ka hoaia i ke kaula, kukuluia, na halakea, kauia na oa a pau a ana ia kahi e moku ai maluna o na oa a pau.

10. Alaila, kuu hou ia na oa a pau ilalo a okioki ia kela oa keia oa, a kalai ia luna o na oa a uuku a hoopoheoheo ia ko luna o na oa a pau. Alaila, kau hou na oa a pau iluna, a paa

to those that had houses, such were called "o kea pili mai" or "unu pehi iole". These were disreputable terms. Not so did those who were not disreputable live, they built themselves houses in the following manner.

4. The man must go up to the mountain forest with his adz and cut down such timber as he needs; then he must carry it down on his back. The posts were short timbers, the rafters long sticks and the pou hanà were long posts that when set up determined the height of the house the man had planned.

5. The kukuna on the sides of the pou hanà are shorter as they approach the corner. The ridge-pole is a long stick as long as the builder plans the house; the upper ridge-pole (kua iole) is as long as the ridge-pole and lashed above it; the halakea are the posts inside the house; the aho are small sticks; this is all the house timber.

6. Then is cut a notch on every post, on the front of the post a projection is cut and back of this a jog in which rests the plate and the rafter which has the end filed into two prongs which ride astride the projection on the post. Both posts and rafters have notches to hold the lashings. When the house is framed it is set up.

7. The corner posts are set up first and made fast. Then a rope is stretched from post to post, a rope at the top, a rope at the bottom, so each post is put in line with all the others.

8. Then space the posts that they be equidistant from each other; then set all the posts of one side and make them firm, and those of the other side in like manner; then the plates are put on the posts in the groove, from one corner-post to another.

9. Then were tied together the post and the plate, and the pou hana set up and made fast to the ends of the ridge-pole. Then the halakea were put in place and the rafters put up and marked at the top where they should be cut off.

10. Then they took down again the rafters and cut on this and that rafter a neck with a head on the upper end of all the rafters. Then they were lashed together and to the ridge-pole,

ia i ke hoaia, kauia ke kuaiole maluna iho o ke kaupaku.

11. Alaila, kau hilo ia ka hale a pau, alaila hoahoia, a paa i ka aho, alaila akoia i pili paha, he lai paha, he lau ko paha, aia no i ka mana o ana pela, pela no e ako ai a paa.

12. Alaila kaupaku a paa, pau ia hana ana, alaila hana i puka, a pau ia, hana i pani, penei ka hana ana, e auwaha ka laau maluna a me ka laau malalo a awaawaa waena, alaila hookomo ke poo o na papa ma keia auwaha keia auwaha o na laau moe aoao.

13. Alaila, houhou i ka iwi kanaka ma kela poo ma keia poo, ma ka auwaha, a ma kia i kui laau, a humuhumu mawaena i ke kaula a paa, alaila, i mau laau i elua, mao o ka puka a maanei o ka puka, e pili ana maloko o ka puka e ku ana iluna a maloko o laila e hooholo ai ke pani, a pau ia hana ana e hanaia ka pa laau a pau ia.

14. Alaila, kiiia ke kahuna pule nana e pule ka oki ana o na mauu maluna o ka puka o ka hale (he kuwa ka inoa oia pule), a pau ka pule ana, alaila komo ka mea nona ka hale a noho ma kona hale me ka oluolu.

15. He hana mau no ka pule ana o ke kahuna ma na hale o ka poe noho pono a pau a me kona alii, a me ka poe hanohano, a me ka poe koikoi, a me ka poe noho kuonoono a pau.

16. Aka o ka poe lapuwale a pau, aole e hana pela, e komo wale no ko lakou hale he hale liilii ko lakou makemake, e waiho koke mai no ke kapuahi ma kahi kokoke i ko lakou poo, e waiho koke mai no na ipu ma ke poo; hookahi no hale o lakou, pela no ko lakou noho ana.

17. Aka, he okoa ka noho ana o ka poe hookuonoono, a me ka poe noho pono, a me ka poe koikoi, a me ka poe hanohano, a me na'lii, e hana no kela mea pono keia mea pono, i mau hale no lakou iho me na wahine a lakou.

18. E hana no i hale e moe pu ai me ka wahine me na keike a e hana no i mau hale a

and the kuaiole was made fast above the main ridge-pole.

11. Then the house was drawn tightly together with ropes and the aho tied on all over the house: then the thatch was put on, grass perhaps, ki leaf perhaps, sugar-cane leaf perhaps, as the owner thought fit, and so the thatching ended.

12. Then was thatched the ridge-pole and the doorway made; this done the door was taken in hand and a rabbet made in the cross stick above and the cross stick below, and a hole made in the centre; then the ends of the boards were fitted in these rabbets resting upon the transverse pieces.

13. Then were drilled, with human bone, holes at both ends through the board and transverse pieces, and wooden pegs driven in; cords through the central holes bound the end strips together; then two sticks were placed one on this side, one on that, and between these and within the doorway the door swung. This work completed, a wooden fence was built about the house.

14. Then was called in the priest to make a prayer at the cutting of the bunch of grass left hanging over the doorway of the house (kuwa was the name of that prayer), and when the prayer was ended the owner of the house entered and settled with comfort.

15. This business of the prayer by the kahuna for the house was in use by the good citizens, the chiefs, respectable men, people of substance and those well-to-do.

16. But the foolish people did not so, but entered their houses without ceremony; they only wanted a small house in which to sleep with the fire-place near their head, and a calabash near at hand; only one house had such people, and so they lived.

17. But in a different way lived the well-to-do folk, and the people who lived comfortably, the men of property, respectable men and the chiefs, each one built enough houses for himself and for his wives.

18. He would build a sleeping house for himself, his wife and children, and large houses

nui no kela hana no keia hana a ke kane, a no kela hana keia hana a ka wahine; he halau kekahi hale, he aleo kekahi hale, he amana kekahi hale.

19. Pela ka noho ana o ka poe kuonoono a pau, oia ka pono a ka poe kahiko o Hawaii nei i manao he ponoia i ko lakou manao ana.

for work by men and others for work by women, also a canoe house, a high house and a house in form of a cross.

19. Such a way of living among the wealthy seemed good to the ancient Hawaiians and they deemed it respectable.

I greatly dislike to interrupt the quaint old annalist, but this is all he has to tell us about the house itself, and we can return to his story and carry it to the end of the chapter when we come to the interior of the finished house; at present we must see what that fine old missionary the Rev. William Ellis wrote about the Hawaiian building as he saw it in his tour around the island of Hawaii at the very beginning of the American missionary efforts on this group.[42]

> The houses of the natives whom he had visited today, like most in this part of the island [Hilo district], where the pandanus is abundant, were covered with the leaves of this plant, which, though it requires more labour in thatching, makes the most durable dwellings. The inhabitants of Waiakea are peculiarly favoured in having woods producing timber, such as they use for building, within three or four miles of their settlement, while the natives in most parts of the islands have to fetch it from a much greater distance. In neatness and elegance of appearance their houses are not equal to those of the Society Islanders, even before they were instructed by Europeans, but in point of strength and durability they sometimes exceed them. There is also less variety in the form of the Sandwich Island dwellings, which are chiefly of two kinds, viz., the *hale noho* (dwelling house), or *halau* (a long building) nearly open at one end, and, though thatched with different materials, they are all framed in nearly the same way.
>
> They begin to build a house by planting in the ground a number of posts, six or eight inches in diameter, in a row, about three or four feet apart, which are to support one side of the house. When these are fixed in a straight line, they erect a parallel row, to form the opposite side. In the small houses these posts are not more than three or four feet high, while in the larger ones they are twelve or fourteen feet in height, and proportionally stout. Those used in the chief's houses are round, straight, and smooth, being prepared with great care, but in general they are fixed in the ground without even having the bark stripped off. Grooves are cut in the top of the posts, along which small poles are laid horizontally, instead of wall-plates, and tied to the posts with the fibrous roots of the *ie*, a tough mountain plant. A high post, notched at the top, is next fixed in the middle at each end, and supports the ridge-pole on which the tops of the rafters rest, while, at the lower end, they are fixed on the wall-plate, each rafter being placed exactly above the post which supports the horizontal pole, or wall-plate. When the rafters are fixed, small poles are laid along, where they cross each other above the ridge-pole; sometimes poles are fastened across like tie-beams, about half way up the roof, and the separate parts of the whole frame are *tied together* with strong cinet, made of the roots of the *ie* plant, or fibres of the cocoa-nut husk. The space between the posts at the sides and ends is now closed up with sticks, larger than a common-sized walking-stick, which are tied with cinet in horizontal lines, two or three inches apart, on the outside of the posts, and extending from the ground to the top of the roof. A large house, in this stage of its erection, has a singular appearance. [See Plate XXVII.]

---

[42] Narrative of a Tour through Hawaii, or Owhyhee; with observations on the Natural History of the Sandwich Islands, and remarks on the Manners, Customs, Traditions, History, and Language of their Inhabitants. By William Ellis, Missionary from the Society and Sandwich Islands. (Second edition.) London, 1827. P. 313.

If the sides and roof are of plantain leaf-stalks, and the leaves of the pandanus, or of ti leaves, each leaf is woven around the horizontal sticks, which gives it a neat appearance, resembling a kind of coarse matting on the inside, while the ends of the leaves hang down without. But if they are covered with grass, which is most commonly the case, it is bound up in small bundles, and these are tied to the small sticks along the side of the wall of the house, with cinet or cord. They always begin at the bottom and tie on the grass with the roots upward, and inclined toward the inside, and continue one row above another from the ground to the top of the roof. The roof and sides are always of the same material, except where the latter are of plantain or ti leaves. The corners and ridge are sometimes covered with fern leaves [Fig. 66], with which they can secure these parts better than with grass, &c. The shell is now finished, and generally, except in the lowness of the sides and steepness of the roof, looks much like a hay-rick, particularly as until recently they never thought of making windows, and had only one aperture, which was the entrance. A large portion of that end of the *halau* which faces the sea, is usually open. The houses of this kind were probably originally erected for the construction and preservation of canoes, for which purpose they are still sometimes used, though frequently occupied as dwellings. In the common dwelling house, the door is frequently on one side. In the old houses the doors are always low. Since foreigners have resided among them, and built houses with doors and windows, the natives have enlarged their doors, though there are yet but few that can be entered without stooping. Some of them also begin to think windows a convenience, but they by no means fall in with our ideas of uniformity in the disposition of them. Sometimes we have seen a house forty or fifty feet long, with the door at one end, and a small window at the other, half way up to the top of the roof. Again, we have entered a house of

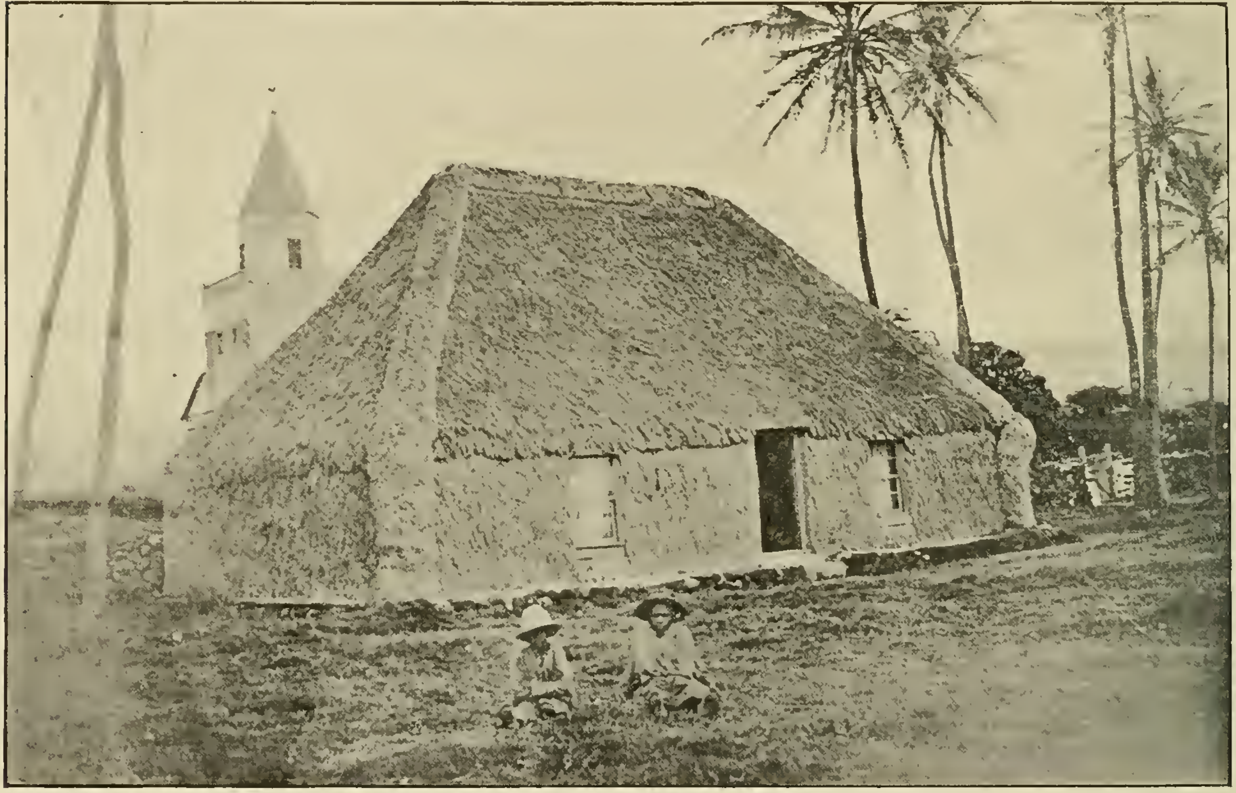


FIG. 66. HOUSE IN WHICH KEELIKOLANI DIED AT KAILUA, HAWAII.

equal dimensions, and in some parts of it we have seen an aperture within a foot or a foot and a half of the floor, generally near their sleeping places. This as well as the other, they call a *buka makani* (wind hole), and assign as a reason for placing it in such a situation, that they sometimes find it close in their houses, and like to have the wind blow on them as they lie on their mats.

The shell of the house being finished, they proceed to fit up the inside, which is soon accomplished, as they have neither partitions nor chambers, and, however large the house may be, but one room and one floor. In preparing the latter, they sometimes level the ground, and spread grass over it, which they cover with large mats made of the leaves of the pandanus. But the best floors are those formed with pebbles, or small fragments of lava, which are always dry, and less likely to be infested with vermin than those covered with grass.

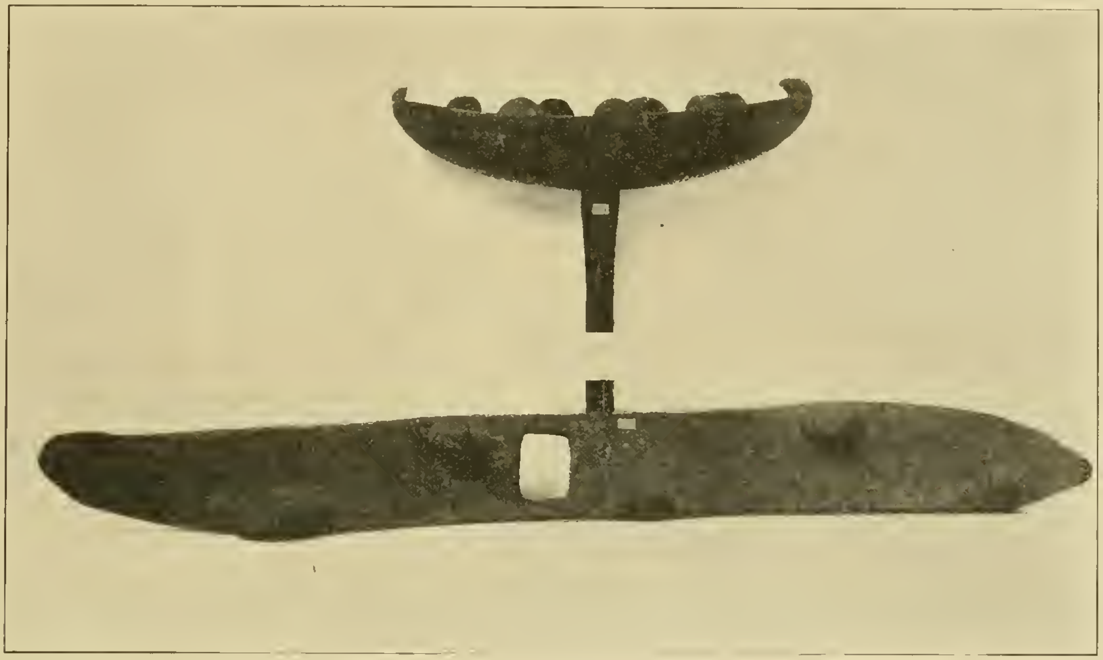


FIG. 67. HAKAKAU FOR SUSPENDING CALABASHES.

The size and quality of a dwelling varies according to the rank and means of its possessor, those of the poor people being mere huts, eight or ten feet square, others twenty feet long, and ten or twelve feet wide, while the houses of the chiefs are from forty to seventy feet long. Their houses are generally separate from each other: even in their most populous villages, however near the houses may be, they are always distinct buildings. Although there are professed house-carpenters who excel in framing, and others who are taught to finish the corners of the house and ridge of the roof, which but few understand, yet, in general, every man erects his own house. If it be of a middling or large size, this, to an individual or a family, is a formidable undertaking, as they have to cut down the trees in the mountains, and bring the wood from six to ten miles on their shoulders, gather the leaves or grass, braid the cinet, &c., before they can begin to build.

But when a chief wants a house he requires the labour of all who hold lands under him: and we have often been surprised at the dispatch with which a house is built. We have known the natives come with their materials in the morning, put up the frame of a middling-sized house in one day, cover it in the next, and on the third return to their lands. Each division of people has a part of the house allotted by the chief, in proportion to its number; and it is no unusual thing to see upwards of a hundred men at a time working on one house.

A good house such as they build for the chiefs, will keep out the wind and rain, and last from seven to ten years. But, in general, they do not last more than five years; and those which they are hired to build for foreigners, not more than half that time. In less than twelve months after my own grass house was built, the rain came through the roof from one end to the other, every time there was a heavy shower.

In some of the islands the natives have recently covered their houses with mud; this, however, does not appear to render them more durable.

While idolatry existed, a number of superstitious ceremonies were performed, before they could occupy their houses. Offerings were made to the gods, and presents to the priest, who entered the house, uttered prayers, went through other ceremonies, and slept in it before the owner took possession, in order to prevent evil spirits from resorting to it, and to secure its inmates from the effects of incantation.

When the house was finished, it was soon furnished. A sleeping mat spread on the ground, and a wooden pillow, a wicker basket or two to keep their tapa or native cloth in, a few calabashes for water and poi, and some wooden dishes, of various size and shape, together with a *haka*, were all they required. This latter article was sometimes like a stand used by us for hanging hats and coats on. It was often made with care, and carved, but more frequently it was a small arm of a tree, with a number of branches attached to it. These were cut off within a foot of the main stem, which was planted in some convenient part of the house[43] and upon these natural pegs they used to hang their calabashes, and other vessels containing food. They generally sat on the ground, and took their food near the door of their house.

The old Hawaiian was a shore-dweller that he might be near his chief animal food,—the fish so abundant about the coral reefs that fringe his island home. Wherever the hard black lava line retired to form a bay, or made a breakwater behind which sand might collect to form a beach there a village could be seen. And even where the lava cliffs made canoe landing difficult, as in parts of Puna, Hawaii, there, that he might be in touch with the ocean, he hoisted his canoe up the cliffs by means of rude davits. Today his descendants have flocked to the foreigners' town and the picturesque little bays and tiny beaches are deserted unless they happen to be a convenient landing to the nearest sugar plantation, and a few piles of stones and perhaps a clump of coconut trees tell the tale of the former fishermen who made a comfortable living by catching fish for his family, or to exchange for other needed things, and to supply his chief.

Near the mouth of the valleys that on every island of the group cut into the mountain mass on every side the old Hawaiian planted his kalo in the ponds so ingeniously supplied with water, and farther landward he had his plantations of sweet potato, waoke and oloná, but his chosen home was still near the sea that had borne his ancestors in their long journey from Kahiki: in this new land it was still the connecting link with the old home which it took him many generations to forget amid the pleasanter circumstances of his new world. We do not find in the ancient songs any glimpse of homesickness, and seldom are these songs tinged with darker shades of flight from enemies[44] or banishment, as often predicated of the immigrants by guessers at their origin.

---

[43] These haka or hakakau were often placed outside the house on the kahua or platform as may be seen in Plate XXVIII. Their common form is shown in Fig. 67.

They lived on the shore and their little world was bounded by *mauka* (towards the mountain) and *makai* (towards the sea), and on that ground timber was neither abundant nor suited to housebuilding. They had planted Hau (*Paritium tiliaceum*) and Kou (*Cordia subcordata*) for shade, and the Ulu (Breadfruit, *Artocarpus incisa*) and Niu (Coconut, *Cocos nucifera*) for food, but none of these is suited for building. The native shore vegetation in most of the Polynesian islands is scant and mean. Immigrant weeds have everywhere landed like the Polynesians themselves, but higher up the mountain slopes, as high as vegetation reaches are dense forests of very valuable trees, mainly of hard wood, and to these forests (*nahelehele*) the intending builder must go.

In selecting a log for carving into an idol, of course priestly magic played its part, and dreams and omens directed the seeker; so the canoe builder trusted to his god, the friendly little elepaio (*Chasiempis*), to indicate a proper tree neither worm-eaten nor decayed, but I cannot say with certainty that any such supernatural intervention was required in the selection of the few sticks of limited size used in the framing of an Hawaiian house. The priest (*kahuna*), who, in the infancy of a people, always has a finger in every concern of his fellow men that conduces to the increase of his power or property, had doubtless selected the position of the intended house, that is, determined what our Chinese neighbors would call its *fung shui* or lucky outlook ("wind and water" rules), and had been duly paid with mats, kapa, coconuts, bananas, pigs, fish or such other portable property as he most desired or his client was best able to pay, and he seems to have allowed the man a respite until the work of building was complete when he again intervenes, as we shall see later on.

The selection of timbers was nevertheless no haphazard choice. The old Hawaiians had a remarkable knowledge of trees and plants; they gave them names and exploited their useful qualities in a way that their descendants have wholly forgotten. They were not likely to pick out a tree that was not durable, and they had a building requirement that the posts and connecting rafters, forming with the ground a pentagon, should be, so far as each set went, of the same kind of wood; with this exception[45] they were free to use any durable and otherwise suitable wood. The best houses, however, were generally built of naio (*Myoporum sandwicense* Gray), uhiuhi

---

[44] The tale of Paao and others was of self-banishment and sorrow at leaving home, but there is little repining in the land which gave them a refuge.

[45] This arrangement must be followed or they would not be able to live quietly and comfortably in the house. Cases have been pointed out to me where this wise precaution had been neglected by the builder or his contractor, and the owner could not live in the house until the defect had been remedied. In cases where the kahuna had made a mistake in the location nothing but a complete removal of the unfortunate house would set things to rights with the gods or their legates the priests. I have been told of one house that had to be moved twice, the gods were so hard to suit.

(*Caesalpinia kauaiensis* Mann), kauila (*Alphitonia excelsa* Mann), mamane (*Edwardsia chrysophylla*), kamani (*Chrysophyllum inophyllum*) and koa (*Acacia koa*), although the last was used more for canoes than for house timbers. Ohia lehua (*Metrosideros polymorpha*) was used in inferior houses, and lama (*Maba sandwicensis*) in houses built for the gods. See the illustration (Fig. 95) of the hale lama below in the account of the modern grass houses.

So far as I have been able to discover, the ancient Hawaiians had no house-building guilds such as were common among the southern Polynesians and embraced a full system of master builders and apprentices. Doubtless at first each man, with the help of his neighbors, built his own simple house. He went up to the forest and collected the timber little by little; brought it down with the help of his wife and children and perhaps his friends. When it was all on the ground he had what in New England, not many decades ago, would be called "a raising bee", when all his friends assembled to lend a hand in raising the frame and thatching the house. Doubtless he regaled his helpers with poi and baked pig or dog as did the New England farmer with cider, pies and doughnuts. If the owner of the house happened not to be *akamai* in housebuilding (skilled in the art), he would doubtless call to his aid a *kuenehale* or man whose knowledge of house carpentry was greater than his own to tell how long and how far apart the sticks should be, and that there was, in later time at least, some definite and well-known rule about all this, is shown in the remarkable similarity of interspaces as well as timber sizes in all of the scores of native houses I have examined all over the group.

A chief had many kuenehale among his retainers, as he was likely to have artisans of the few sorts known among the Hawaiians, and when he desired to build a house, under their direction some men went to the forest for trees from which to shape the house timbers, others to collect the long slim sticks needed in great quantity for the *aho*, others to braid the cord that was to hold the frame together and attach the thatch to the aho, while others collected the pili grass for thatching.

The timbers were not fashioned in the forest, except so far as to cut a neck at one end to which the rope used in dragging the log down could be made fast. Most of the timbers could, however, be carried on the shoulders of the muscular old Hawaiians. When on the ground they were generally hewn into a uniform surface with the stone adzes, although in poorer houses I have seen posts simply stripped of bark, if this had not been torn off in the dragging over a rough trail. In most of the woods enumerated as preferred for house building it was important to cut away all the sapwood to insure the durability of the posts. The illustration given will show the adze marks in the hewn timber (Plate XXVI, and Figs. 77–82), and these were never covered with sennit as in Tonga and Samoa.

The stone adzes were the principal tools used in all the house framing, although fire was used at times in felling trees. When foreign tools came to the Islands they were not at once popular: the adze, they said, was too heavy (for men who swung a ten-pound stone adze-head!); and when the superior durability of the metal was acknowledged, the native carpenters still kept the *au* or handle of the stone tool and used plane irons attached with coconut cord in the ancient way. I have seen old canoe makers use a foreign adze to roughly excavate the canoe log and then return to the old stone *koi* to put the proper finish on their work.

In cutting the deep notch in the rafters a stone file was often used, and the ever useful pump-drill (Fig. 68), a tool common throughout the Pacific, served to bore the holes for the pins in the door. To dig the post holes the universal *oo* or digger, a tough stick of convenient length sharpened at one end like a duck's bill, was used. Not a hammer, not a nail. As in the building of Solomon's Temple, "there was neither hammer nor axe nor any tool of iron heard in the house while it was in building." We may add that the general confusion of tongues and shouting among the many workers would have smothered the rat-tat of a dozen hammers.

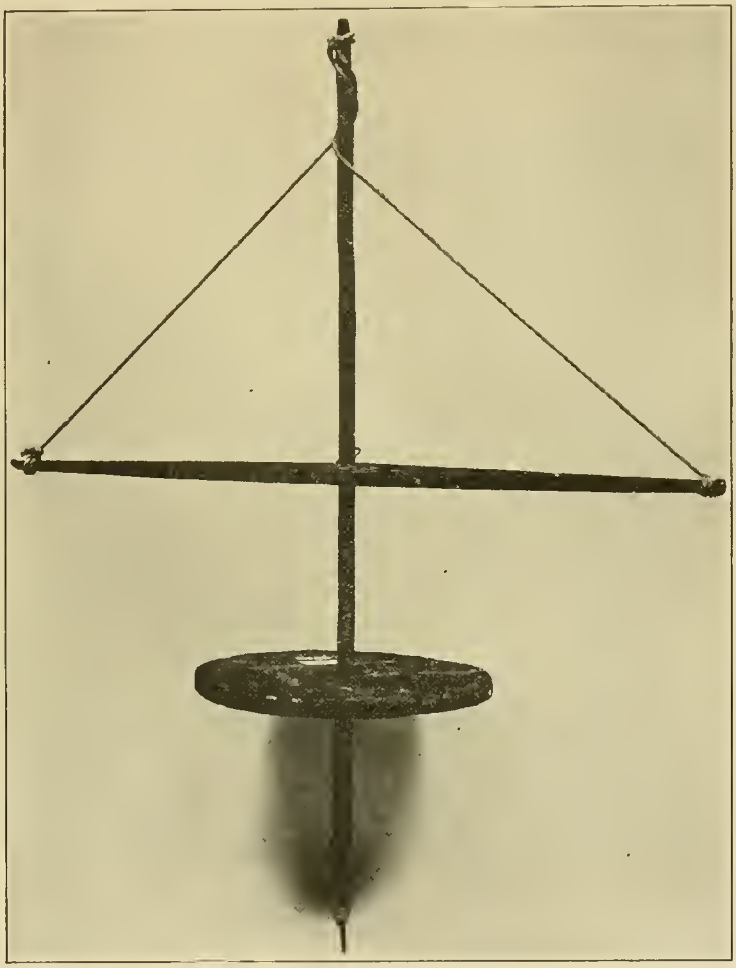


FIG. 68. HAWAIIAN PUMP-DRILL.

In place of nails or screws the Hawaiians used cords of various sizes (Plate XXIX) for fastening together the different parts of a house. The largest *aha* of braided coconut fibre served as cable for the stone anchor of a canoe: a size nearly as large fastened the outrigger to the *ama* and these to the gunwale of the canoe. Then came the size used to tie the principal framework of the house together. Smaller cord attached the *aho* to the rafters and posts, and still smaller fastened the tufts of grass to the aho in thatching. The size was also regulated by the strength of fibre: thus a cord of oloná was stronger than one of coconut fibre of equal size, and the latter stronger than one of twice the size made of grass.

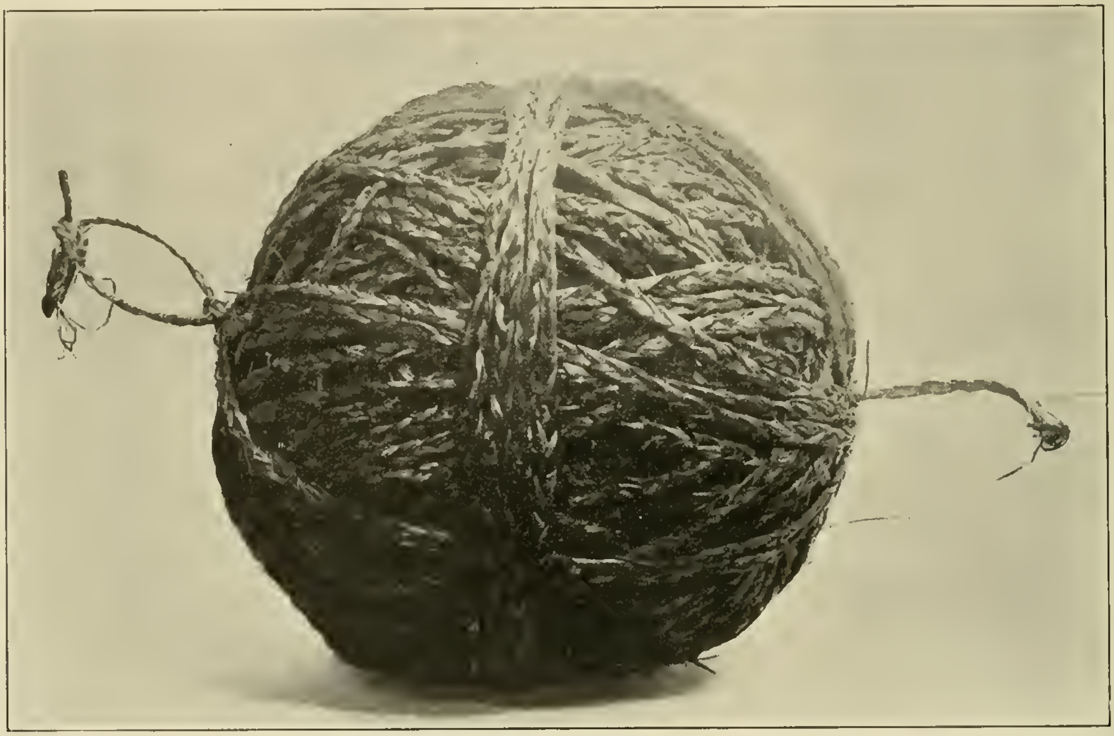


FIG. 69. BALL OF BRAIDED GRASS.

While men were cutting the timber in the forest on the mountain side, others were twisting or braiding cord and winding it into balls often twelve or eighteen inches in diameter, as shown in Fig. 69. On most of the groups this cord or sennit making was pastime of the elderly men whose product was always in demand, and I have elsewhere[46] noted the ingenious method of winding sennit which has been adopted by modern spinners as the best form (Fig. 70). Ellis mentioned ieie fibre as used in the Hilo district, where it was abundant. The house from Kauai re-erected in the Bishop Museum, which is fully figured in Plates XXVI–XXVIII, and Fig. 86, was fastened together by cord (*ahuawa*) made from the braided leaves of *ukiuki*, a liliaceous plant. This was made into large balls and used throughout as more convenient to procure than the coconut fibre which is now never imported as formerly, from the southern islands, and is not prepared to any commercial extent on this group. Neither oloná nor waoke was used commonly in housebuilding, although cord of *hau* served in poorer houses.

---

[46] Bishop Museum, Occasional Papers I, Director's Report for 1899, p. 22.

It is surprising to one not familiar with thatching to see how much grass is needed for the purpose. I have thatched a house in the forests of Guatemala with split palm leaves and the material seemed but little bulkier than ordinary shingles, but the pili grass for the Museum building made a pile almost as large as the finished house. This grass (*Paspalum orbiculare* or *Heteropogon contortus*) was common enough all through the coast region and up the larger valleys, and its collection was left to the women and children. In the *corvée* at the building of a chief's house described by Ellis, chiefs often remitted a suitable portion of the district taxes in return for especially fine timber or grass brought by their feudal tenants.

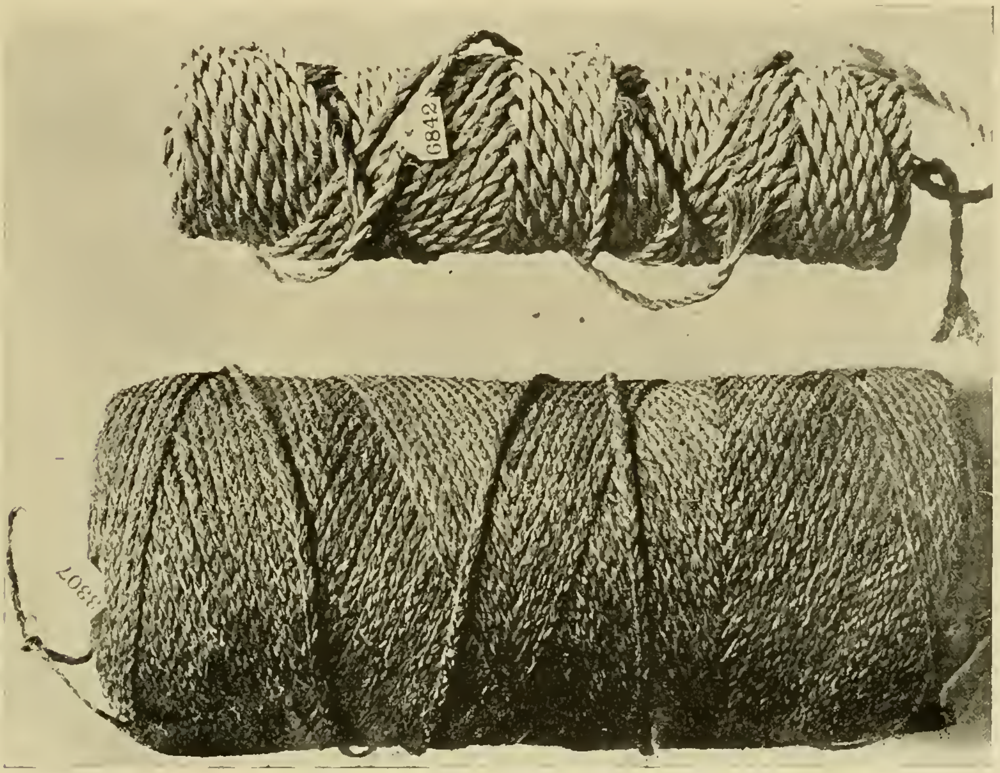


FIG. 70. POLYNESIAN SENNIT IN NATIVE ROLLS.

If, instead of grass, pandanus leaf was the thatching material, it was at hand over almost all the inhabited part of the group, although now nearly eradicated from regions where cane is cultivated: its use for mat-making was more important than for thatching. Of the other material occasionally used, as coconut leaves for screens or lanai roofing, ki plant or sugar-cane leaves, all were in or about the villages. As a rule, I believe, the tenants of a chief had free timber from their chief's land which extended from the sea to the mountain top, but I am not entirely sure, for my sources of information on this point are not quite satisfactory. There was no dearth of wood until the white man with his all-consuming fires came upon the land, but the difficulty of transportation was sufficient to guard against waste.

We will anticipate a little and leave the collected material on the ground—though not so long as it would doubtess be left by the builders—and sketch out the skeleton of the building, much as a modern architect would examine his plans, that the reason for the forms and sizes of the various sticks and their names may be clear to the reader.

The grass house placed in the Bishop Museum and represented in Plates XXVI to XXVIII we have selected to show the different stages of construction,[47] but it is not the oldest and simplest form, which still existed forty years ago in out-of-the-way places, and sometimes among the cluster of houses in a chief's residence.

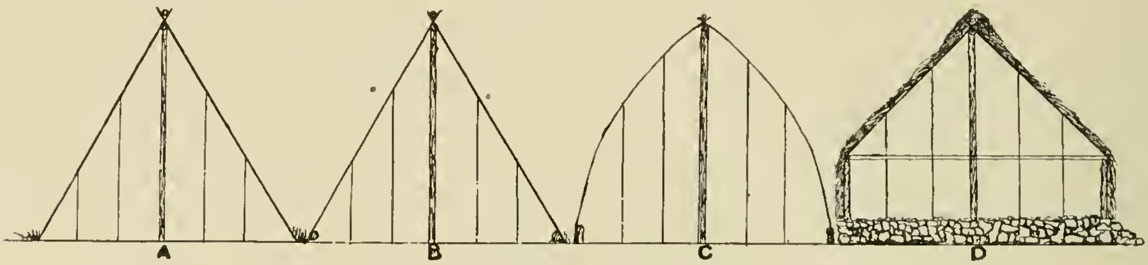


FIG. 71. DIAGRAMS OF HOUSE FORMS.

Two posts, the *pou hanà*, a name which I should translate the *working posts*, were the earliest portion of any grass house, as they would be of any lean-to camp, and the rudest *hale kamala* or shanty. They supported the two ends of the *kaupaku* or ridge-pole. The Marquesan house had these three elements, and in that curious house the rafters reached from the ridge-pole to the wall or the ground, on one side only. In the oldest form of Hawaiian grass house known the rafters extended to the ground from the ridge-pole on either side (see the diagram, A in Fig. 71). At first the rafters were planted in the ground or fastened to stakes. This frame was really a roof, and the house to this point was only roof. However steep the roof, the interior space was smaller in proportion as it rose from the ground: only on the ground level could one enjoy the whole horizontal space the roof covered. This inconvenience led the French architect Mansard to borrow the roof that bears his name, and the Hawaiian builder to bow his rafters as shown in C of the figure. This was a favorite form of house and is shown in Weber's sketch on Kauai, made at Cook's first visit to the group in 1775 (Fig. 64).

---

[47] The frame of this house was found in a valley on the northern side of Kauai, by the late W. F. Deverill, and the owners of the land, Messrs. Knudsen, kindly gave it to the Museum. It is made of Bastard Sandal-wood, Naio of the natives, and uhiuhi, two very hard and durable woods, and in the opinion of Mr. Deverill, a good judge, must have been made a hundred and fifty years ago. At any rate the wood shows plainly the marks of stone adzes, and the complete frame is the oldest I know of. The naio is *Myoporum sandwicense*, and the uhiuhi is *Caesalpinia kauaiensis* Mann.

Very soon, probably, it was found best for the stability of the house to fasten the lower end of the rafters to a stick of equal length and parallel to the ridge-pole: this became the *lohelau* or wall-plate. In the Waimea houses of Cook's time these plates were raised on posts, where they were on the banks of the Waimea River, to guard against floods, but the floor remained on the level of the plate which thus became a sill.

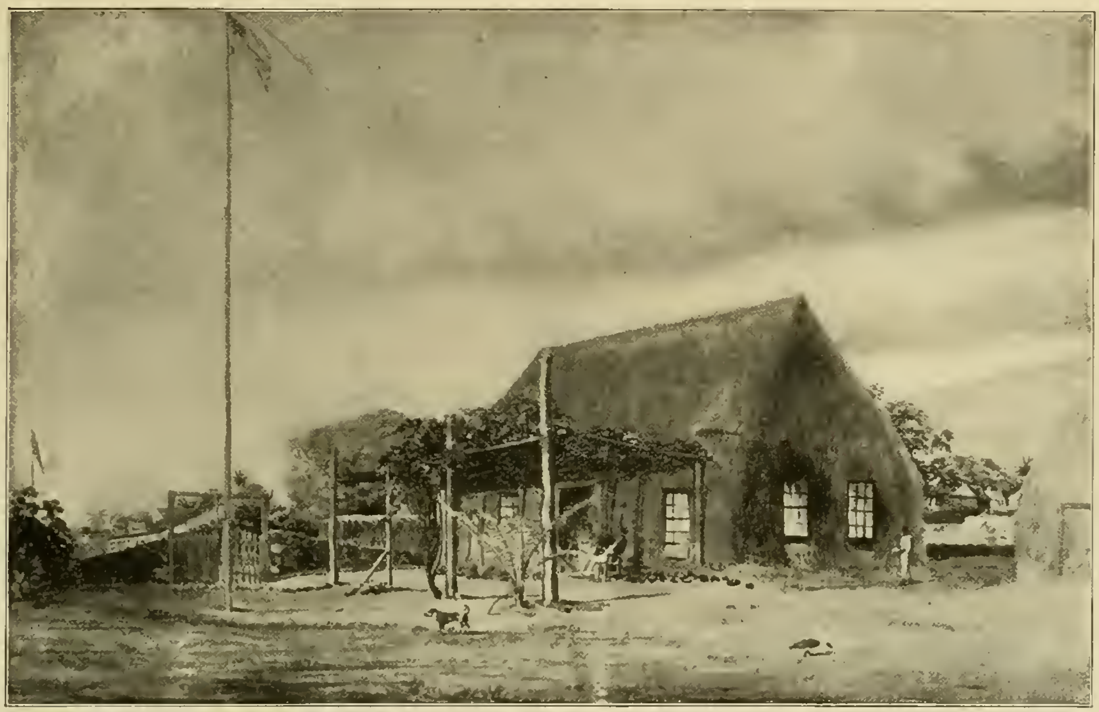


FIG. 72. HALE KAMANI AT LAHAINA.

The space under this form of house was, in the absence of flood waters, an agreeable living room for the family (including the pigs, whose close connection with man in the Pacific has already been noted), and this basement room has always been a favorite with Hawaiians. When the foreign houses were built they were generally raised on posts some feet from the soil, and in such case the house owner, if Hawaiian, by preference occupied the space beneath the floor. When the Princess Keelikolani built her palace in Honolulu, with drawing room and every convenience on the main floor, which was reached by rather high doorsteps, she preferred to live in the cool basement.

Now, if we suppose the houses of roof only, raised, as shown in Weber's picture, four or five feet above the ground, it would be a simple step to lower the floor and cover in the supporting posts with a wall. This change would make the complete house of which all later ones are modifications. One of the most perfect forms of this typical house is shown in Fig. 72, a house built by Kauikeaouli (Kamehameha III) for his sister Nahienaena. The windows are of course foreign additions,[48] but the porch in front was quite in accordance with native style. Other forms of grass houses we shall notice later, but if we have shown that the skeleton in all is essentially the same, growing to its full development by degrees, we are ready to return to our material and watch the old natives, clad solely in the *malo*, put together the frame. It is always a fascinating sight to see a house take shape, and not less so when the active agents are animated bronze statues.

The best houses were built on a *kahua* or platform of stone, usually rounded stone laid dry, but we see in Fig. 65 that the houses of Kalaimoku, the famous prime minister of Liholiho (Kamehameha II), were without this desirable foundation. The two corner posts of the front were first planted whether in the stone kahua or in the ground, and they were fashioned, as Ellis tells us, smoothly for the chiefs and left even with the bark on for the meaner houses, and the top was cut as shown in Fig. 73. Most of the old posts I have examined were not strictly smooth but bore the marks of the stone adze as may be seen in the illustration. The large post shown in Figs. 74-75 was as smooth as if water-worn. A deep groove was cut to receive the *lohelau* or plate: the inside lip of this groove was cut flat and shorter than the outer one, which was fashioned into a point to engage the fork of the rafter which rested on the plate which in turn rested on the flat back of the post. A chin (*auwae*) is cut below the front peak (*ule*[49]) to hold the lashing as shown in Fig. 73. In one case, however, advantage was taken of a projection to cut holes through

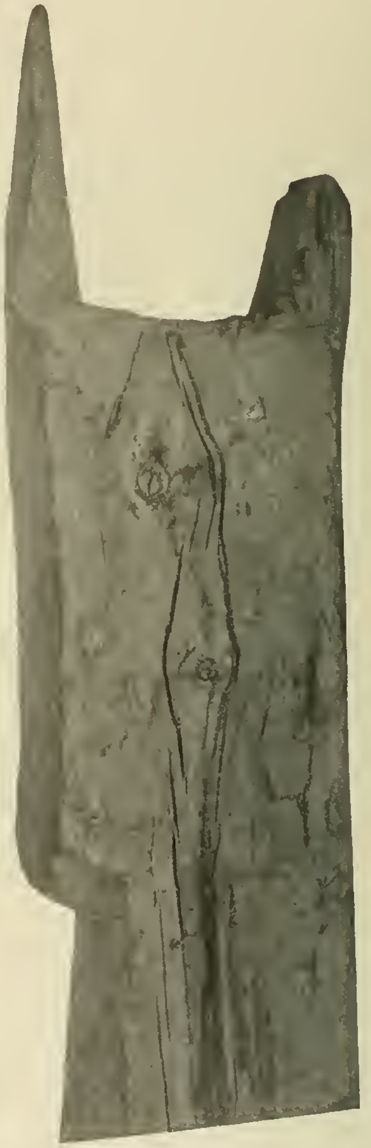


FIG. 73. THE POU OF A HOUSE.

---

[48] This house was leased to, and inhabited by, Hon. Gorham D. Gilman of Boston from 1851 to 1861, while he was a merchant in Lahaina, Maui, the ancient capital of the group, and to him I am indebted for the interesting view of this fine house.

[49] It was quite in accordance with the spirit of the Hawaiian language to use such terms: ule=penis, kohe=vagina: but in English we use the terms male and female screw.

which the lashings were passed[50] (Fig. 75). All this shaping has been done while the timbers were on the ground and doubtless the kuenehale has had the holes dug and the posts cut to a proper length before the raising. But no: this pole is too long and the hole has to be deepened not only with the *oo* but with a noise as that which overthrew the walls of Jericho: or the hole may extend to a large rock, and then the pou has to be cut shorter. All these delays and contretemps are taken with perfect good nature: time is of little value, and mahope is better than today! When at last these corner posts are placed to the satisfaction of the kuenehale, a line is fastened between the posts at top and bottom, and the other posts, which are of the same shape as the corner posts but sometimes

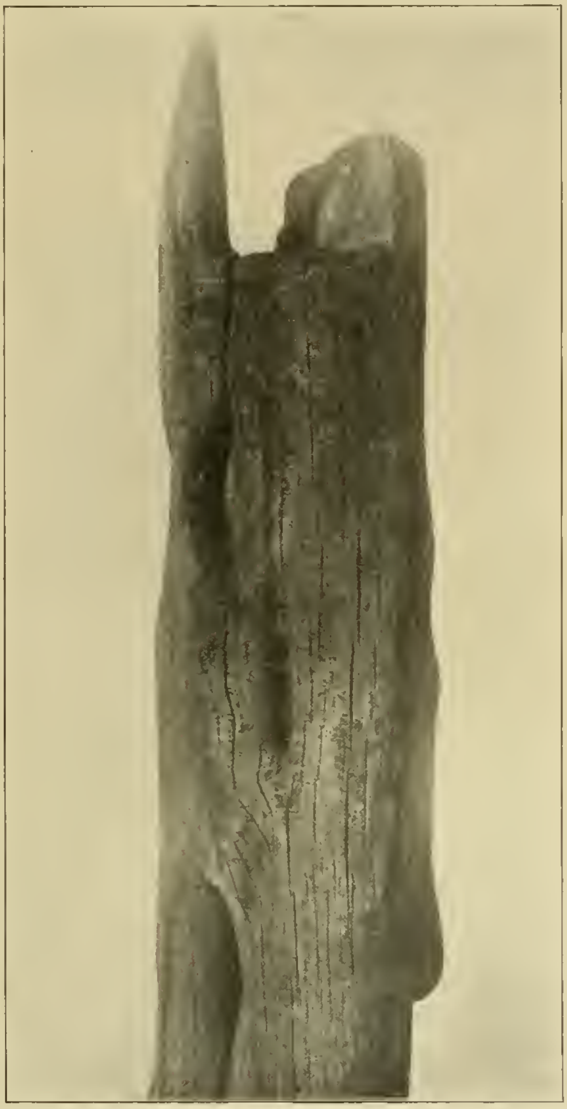


FIG. 74. POU FROM WAIALUA.

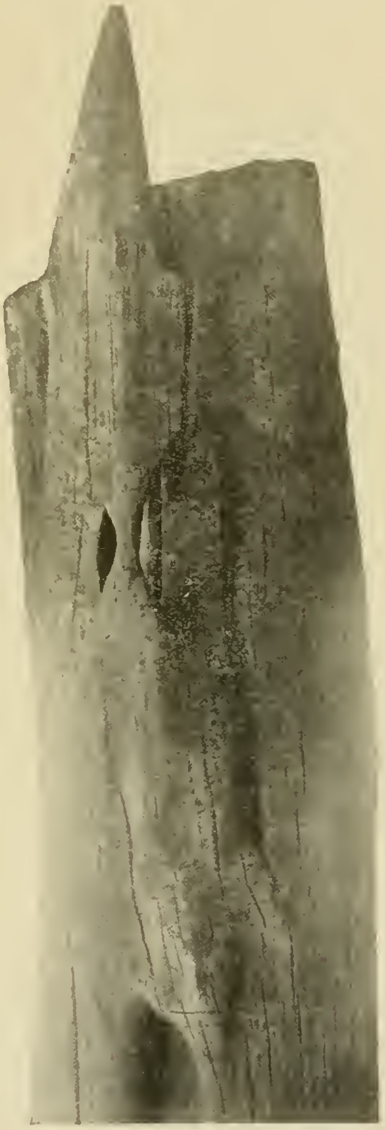


FIG. 75. POU FROM WAIALUA.

---

[50] This large pou, which measures 36 inches in circumference and is 9.5 feet long, was found by the Rev. W. D. Westervelt in a swamp at Waialua, Oahu, and by him given to the Museum. The log is hollow, and was probably so when first used.

less in diameter, are placed in line, with equal interspaces, and firmly fixed in the ground; the plate, lohelau, is then placed in its groove and temporarily bound to each with cord.

The opposite side is next erected, and the old Hawaiians must have had some difficulty, in case of a large house, to get the correct position, for they do not seem to have had the method of the Maori of the *hauroki* or measurement by diagonals; at least, I find no word in the Hawaiian language corresponding to this, and while the small houses were generally fairly rectangular, the large *heiau* or temples were often far from it when tested by the accurate methods of a survey.[51]

The gable ends were next taken, and a cord the length from centre to centre of the corner posts was doubled to obtain the point midway between the posts, where the highest posts, those that determined the height and so the pitch of the roof, were planted, being aligned as were the posts of the front and back. These *pouhanà* were notched on the top to receive the ridge-pole, and like the carved centre-post of the New Zealand house, had something of a sacred character, although not to the extent, perhaps, of the Maori post. Under one of these was buried the victim anciently offered to the gods,[52] although some authorities claim one of the corner posts for this honor. As there is a special name for this post, *pou o Manu*, it would suggest that it might be any convenient post. I have never dug up any bones on the site of an old house, with a single exception: in my own garden I found the skull of a young male about where an ancient house stood, but there was nothing to show what post of the house stood where the skull was found; and it might have been a simple interment. It is so long since the custom of sacrifice ceased that probably no bones would remain. By analogy in considering the custom of the other Polynesians, I am inclined to believe that a pouhaná was the chosen post. Half way between the pouhanà and the poukihi came the *kukuna*, posts planted in the ground and lashed to the end rafters. Stout ropes were then bound around the house to hold the whole frame tightly together until the rafters were in place.

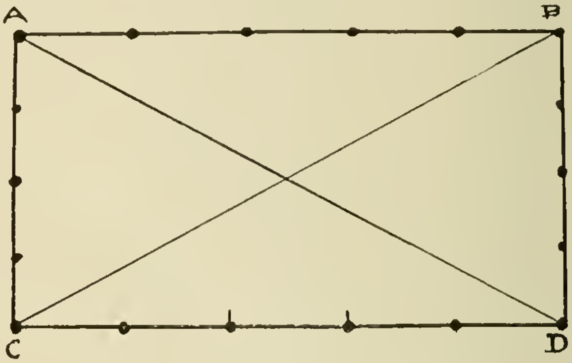


FIG. 76. DIAGRAM OF HOUSE PLAN.

---

[51] This common measurement is simply this, referring to Fig. 76: AB = CD and AC = BD, but it is not a rectangle unless AD = CB.

[52] While there can be no question that the offering was made to secure the stability of the house, there is question as to what god the offering was made. The name of the post at the base of which the victim was placed was *pou o Manu* which hardly lightens the difficulty. Manu was the name of the two gods standing at Lono's door. Manu, meaning throughout Polynesia a bird, was in mythology applied especially to "The great Bird of Tane, the Bird that goes round the heavens." In Hawaiian it is The great white Bird of Kane. Among the Maori the *kiwi* or *Apteryx* is called Te manu huna a Tane, "The hidden bird of Tane." On the other hand the Polynesian word manu means to launch, to cause to float, to establish, and the name of the post may merely signify a memorial of the founding of the house, a sort of "corner stone".

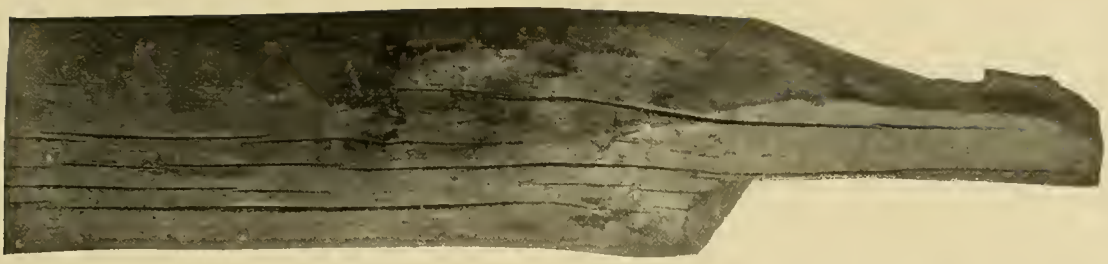


FIG. 77. UPPER END OF RAFTER.

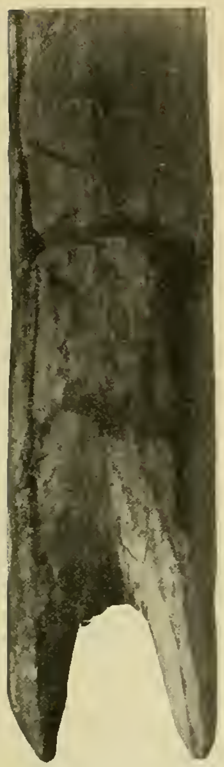


FIG. 78.
UPPER SIDE OF LOWER
END OF RAFTER.

There were then ten posts that had special names in every house: two pouhanà, four poukihi and four kukuna; the last were not cut on the top as the others were. All the other posts were alike and designated simply pou.

The *oa* or rafters equaled in number the front and back posts, and the lower ends were cut all alike into a heel and fork, the latter called *kohe* as it was to fit the *ule* of the post (See Fig. 78). They were put in place resting on the plate and post with the upper end resting on the ridge-pole, and marked where they should be cut off above the ridge-pole. They were then taken down and the upper ends cut in pairs as shown in Fig. 77. I have already spoken of the importance of the requisition that the two posts and two rafters forming a series should be of the same kind of wood. I fancy that in the poorer houses, which must

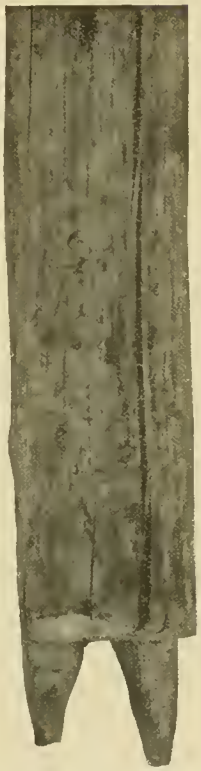


FIG. 79.
UNDER SIDE OF LOWER
END OF RAFTER.

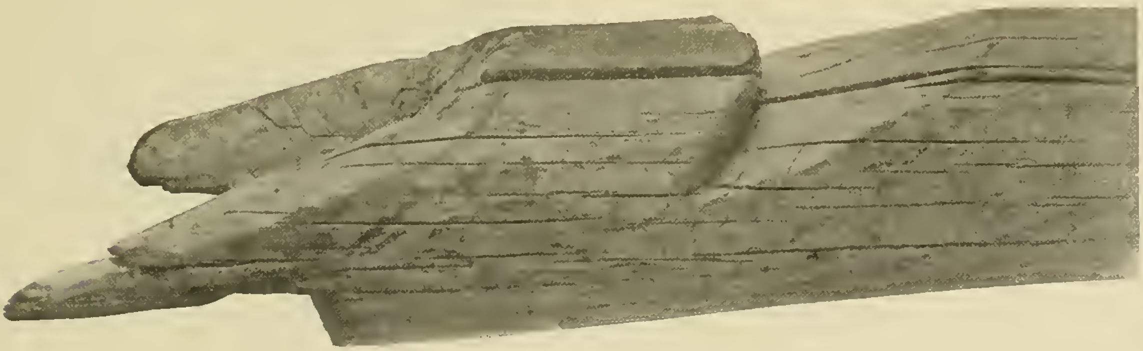


FIG. 80. LOWER END OF RAFTER.

sometimes have been made of the ruins of other houses, this was often neglected, and any odd sticks were doubtless used at times, but I have never noticed in the good houses I have examined any deviation from this rule. The union of the pair of rafters above the ridge-pole was an interesting one, and calculated to greatly strengthen the roof, for above the projecting rafters, which were halved to come into line, and parallel to the *kauhuhu* (Fig. 81, A) was the *kaupaku* (B) or supplementary ridge-pole. Not only were the four sticks lashed firmly together at the point of intersection, but between the rafters the two ridge-poles were also tied tightly together (Fig. 81). Cross bracing was unknown to the old Hawaiian as to other Polynesians, and such braces were not needed and perhaps better away, for a certain degree of elasticity was desirable in a grass house that would be fatal in a boarded house. Only in the Kusaien gable (Fig. 42) is the property of the stiff triangle used to support the ridge-pole, and then it may have been more in the way of ornament than as a mechanical device.

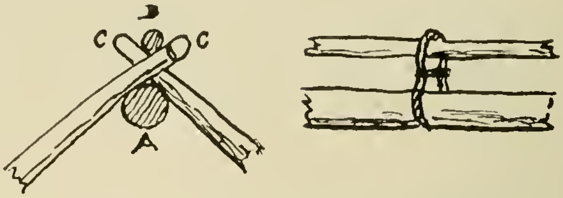


FIG. 81. JUNCTION OF RAFTERS.

While the rafters are being cut the workmen are tying together the pou all around the house, leaving only the space for the door, with *aho*, small horizontal poles about the size of a stout walking-stick, and at intervals of five to seven inches. (See Plate XXVII.) When the rafters are again in place they are first tied together with the flat sides of the neck in contact and then made fast to the ridge-poles and finally to the pou and lohelau. The lower lashing is well shown in Fig. 82. The attachment of aho is then continued all over the roof, and in very large houses cross beams are also added, but this is seldom needed, the aho are so stiff a bracing. Where the depth of the house requires it, vertical aho are placed between the gable-end posts to support and stiffen the horizontal aho. How a house looks in this stage is shown

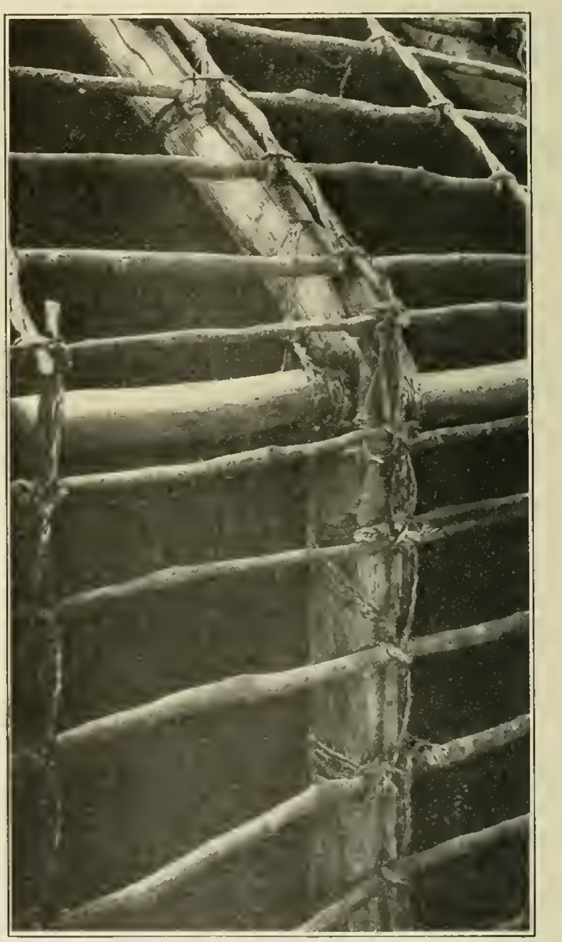


FIG. 82. JUNCTION OF RAFTER AND POST.

in Plate XXVII. It is in fact a huge inverted basket. The long ropes that bound the frame tightly together are now removed and the spring of the frame tightens all the lashings in a very satisfactory way. As shown in Fig. 82 the aho are not all tied to the rafters, but mainly to another pole of about the same size as the aho, which is lashed at every fourth or fifth row to the rafter as well as to the horizontal aho. This system saves much cord and seems very firm. The thatching is now in order.

I do not know that a separate guild of thatchers existed in Hawaii, but it is certain that the corners and doorway were always entrusted to some skilful persons, the main thatching being done by friends or neighbors of the owner. It was particularly difficult to make the junction of the roof and gable walls weather-tight, for the roof never projected beyond the plane of the wall, which was vertical or nearly so. To close this against rain several devices, more or less effectual, were used, such as braiding the tufts of thatch together, or bonneting the seam with thicker grass, or, more commonly, with fern stems and fronds; the latter device is shown on the house in Fig. 66; but it seems never to have suggested the safer projecting portion of roof, shown in the New Guinea, Solomon Islands, Maori and other houses of the Pacific region. It is not impossible that the hipping of the gable ends as shown in that figure, and in the illustrations of the house in this Museum, was suggested by the acknowledged difficulty of making a tight joint; at any rate the hipped gable seems to have

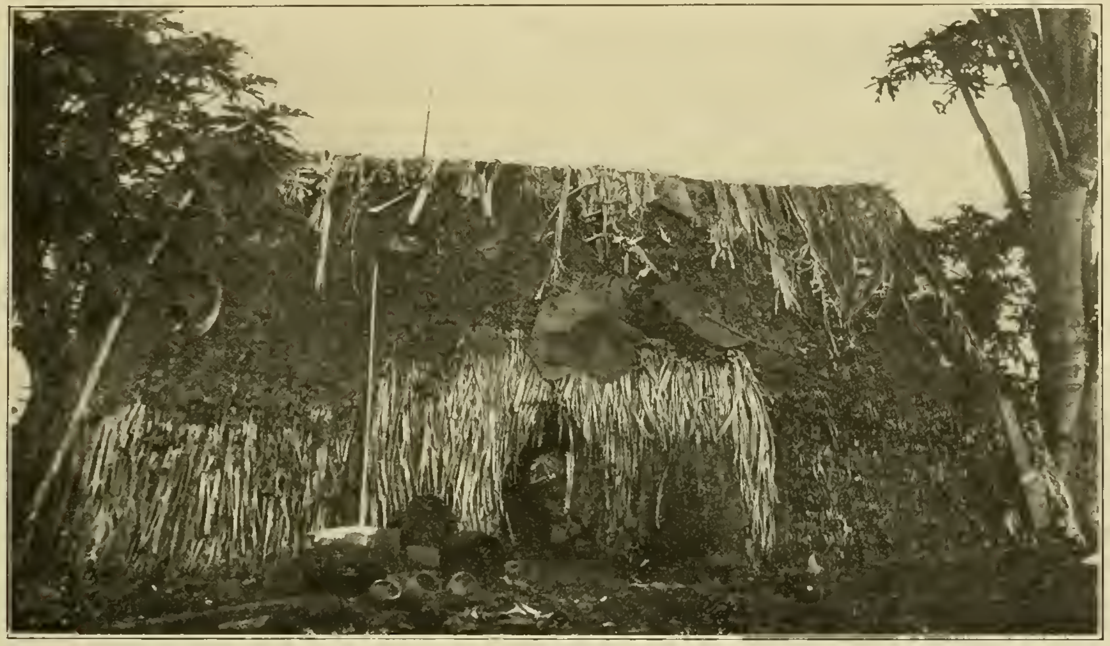


FIG. 83. HOUSE NEAR HILO NEEDING A NEW ROOF.

been a later form of roof, and thence to the end of the age of grass houses on these islands was the more popular one. The rainy Hilo, as it used to be, had houses of this form in very early times, while in the dryer parts of the group a tight roof was not so important a matter. That the whole roof leaked when neglected is shown by the patchwork covering the house given in Fig. 83, from a photograph taken by my friend Charles Furneaux, Esq.

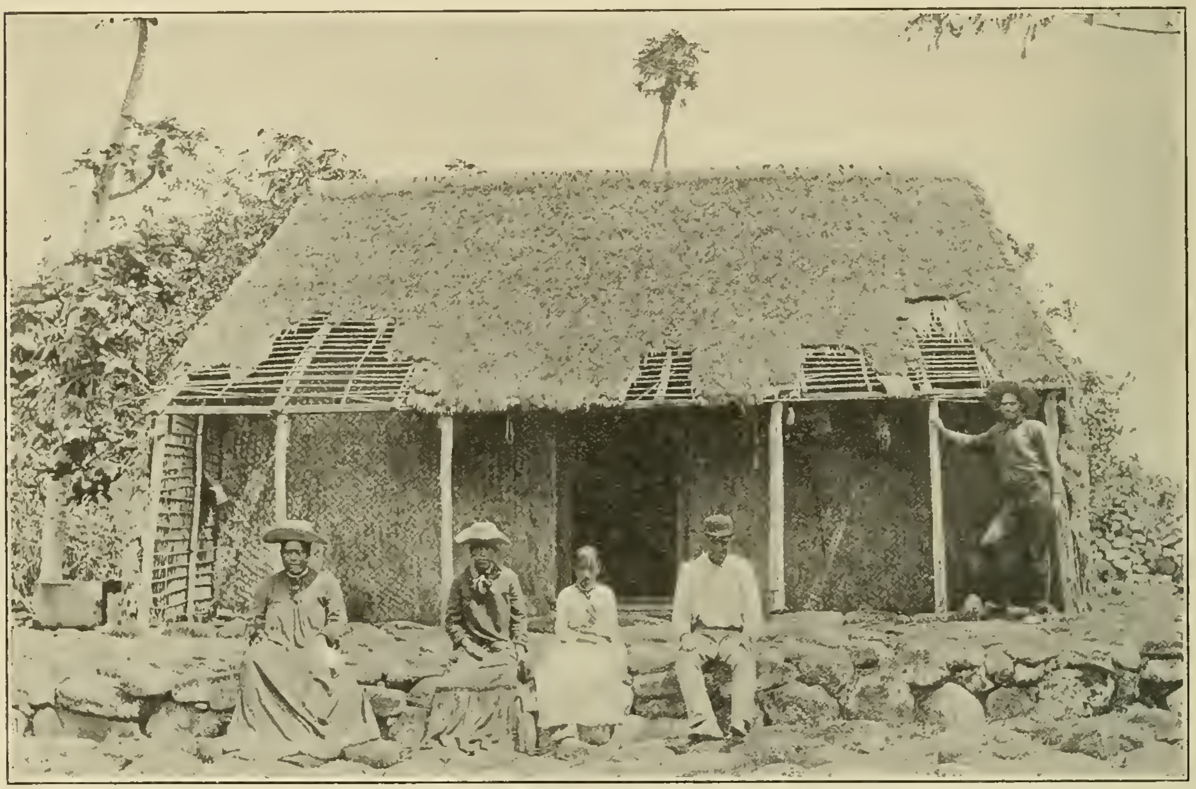


FIG. 84. HOUSE IN PUNA, WITH LANAI.

Turning from this distressful scene of decayed thatch, which was common enough in the last days of the grass age, we may set the thatchers at work to cover our skeleton. The general native word for thatching was *ako* whatever the material used; when it was well and smoothly done the term was *lole:* hence the art of thatching a house was called *lolelau.* There were other words used in different parts of the group, as *paihale*, because it was walling in a house; *papai*, because the tuft of grass being tied to the aho was struck with the left hand to compress it under the cord.

In the neatest houses there was a lining of banana stalks dried, sugar-cane leaves, or, where the leaf was abundant, of hala (Pandanus) leaves; but this was a mere appearance of neatness, for it was a capital *nidus* for the many insects that in this climate infest such houses. The plain grass when *lole*, was more desirable, but even the grass itself was a pleasant harbor by day for countless cockroaches which came out at night to disturb and pillage. These insects are of considerable size, often two inches long, and of remarkable agility and keen appetite. I well remember my first experience with them in a neat grass house in Puna, Hawaii. Father Titus Coan, of the American Mission, and I were traveling along the shore of that now almost deserted region, that grand old missionary on one of his pastoral tours, and I availing myself of his guidance, when we spent a night in a very comfortable native house[53] (Fig. 84). As soon as the kukui nut candles and the native stone lamps were lighted, that one of the younger members of the family, our hosts, might read the bible in the family worship, the unbidden congregation of cockroaches assembled, and it required the active services of a lad to brush the great insects from the page which would otherwise have been covered. When we stretched ourselves on the mat bed, rolled in a sheet of kapa, we had the better of them, for every time we rolled over several gave up their lives in loud pops, and in the morning we found windrows of the crushed remains on either side of each sleeper. They, however, had their revenge, for during the night they ate so much of my bridle that it could not be used until mended, and the oiled silk lining of our hats was reduced to bare threads; one of the party had the entire enamel eaten from his patent leather shoes, leaving rough brown leather. This is one disadvantage of grass houses.

Supposing the lining in place, next the aho, the thatcher begins at a corner with a very thick bunch of grass which he ties firmly to the lowest aho in such a way that it extends somewhat around the corner; the roots are upward, and the cord is bound in a single turn, and the next tuft quickly placed close at its side. The early part of this process can be seen in Plate XXVII, as done on the house in the Bishop Museum. The lower row must lay out on the ground or kahua, if there is one, and the succeeding ones overlap; the durability of the roof or wall and its impermeability depend much on the thickness of these successive layers. We have seen that in the Fijian house the thickness is very great, much exceeding any I ever saw on the Hawaiian group, but then it must be remembered that I saw this work here only in its decadence.

The simple process of attaching the grass continues from the ground to the ridge-pole, and then comes another process entirely: the bonneting may be done in several ways, but the ground and object of each is the same, to so unite the rows of thatch, which on the peak are quaquaversal, that no water can percolate, or be forced in by the wind. Up to this point the skilled thatcher strives rather to make the grass lay flat and present an even appearance on the inside of the house, if there be no lining, and the outside is left to look after itself for the present. The method most commonly used in good houses consists in braiding the half of the grass on each side with a stiffening of fresh grass until the whole forms a compact roll slightly protuberant.

---

[53] This picture was taken twenty-four years later, when the roof was greatly out of repair, but it serves to show that a well-built house in that dry region will last a long time, when cared for. It seemed likely to last another quarter century, but its doom had sounded, and when, a few years later the family removed to town, the old home soon fell to decay and has long since disappeared, except the kahua or platform.

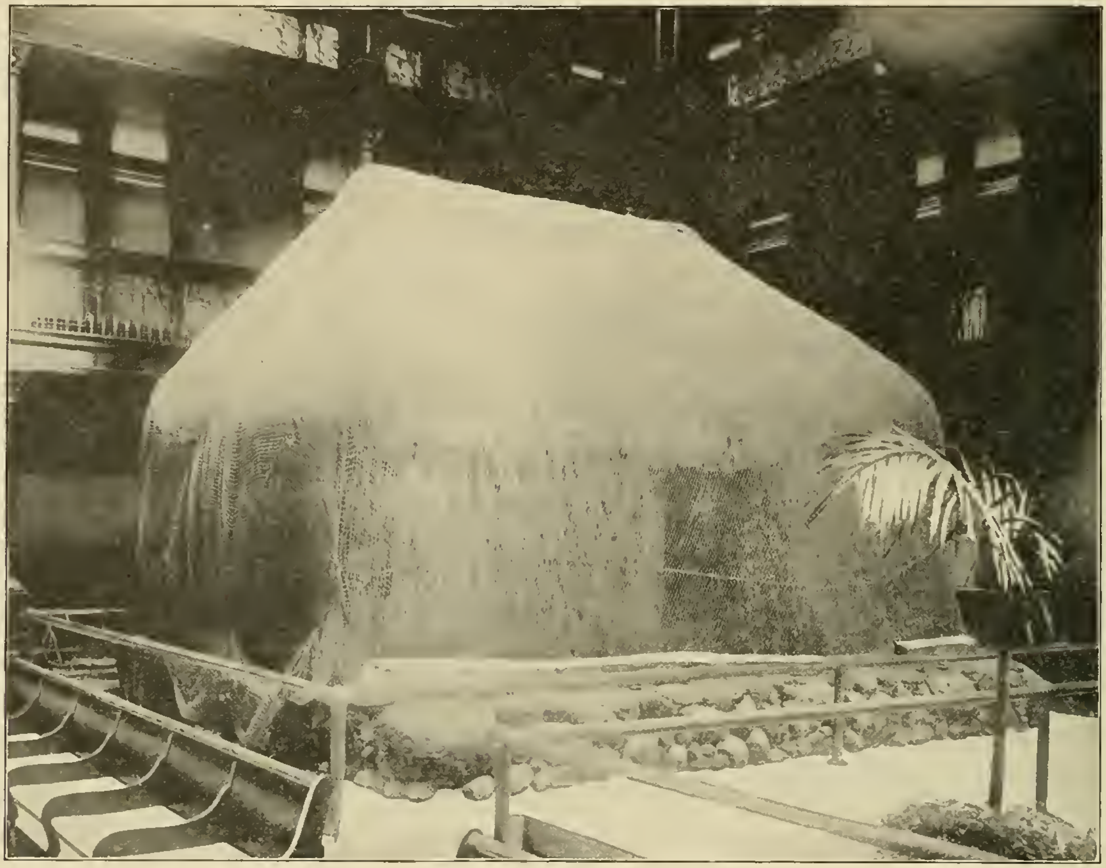


FIG. 85. GRASS HOUSE WITH NET OVER IT.

(See Plate XXVIII.) Where a trimming of grass or fern is used, as in Fig. 66, the house at Kailua, so much care is not expended, but reliance is placed on this trimming to act as ridge-board. The absence of chimney and of all openings except the door greatly simplifies the work.

The grass on each side of the door is carefully braided both for protection to the grass and for the comfort of the persons passing in or out. In the most modern grass houses, those built after the advent of foreigners, boards were substituted for the more difficult finish of braiding.[54] Thatching with grass leaves the aho uncovered within the house, not an unsightly finish if the thatch is well laid; but it must be remembered that there was not enough light by day from the very small door, to show the finish, and by night the feeble light of kukui candles, or even of several oil lamps gave to the aho nothing more than the appearance of dark horizontal lines on a lighter ground. No wonder then that the interior finish was not an object of great solicitude.

---

[54] This was the case in Kalaimoku's house (Fig. 65) dating from some time about 1835.

The Hawaiians had a thatching needle (often a rude substitute was used), but seldom used it except on the raised edgings where it was not always easy to pass the stiff cord through the thick mass of grass or fern leaves.

When the thatching was complete, it was customary to put heavy nets over the whole building to compel the grass to dry evenly, and not curl up. This is seen in the picture of the Museum house (Fig. 85). Two or three days of dry weather suffice to fix the grass in an orderly way.

The door was a matter of more carpentry than the rest of the house, and its construction was not easy where there were no sawmills to furnish boards. These must be hewn from logs, generally split logs of no great size, and fitted to two thicker pieces of wood the length of the door width, which were rabbeted to receive the boards. To these transverse pieces the boards were fastened by pegs of wood inserted in holes bored, according to Malo, by drills made of human bone. To give additional strength a larger hole was drilled in the middle of the transverse pieces through which a cord was passed to bind them together.

As to the hanging of the door in olden times there are two opinions: Dr. Emerson, in his translation of Malo, says they were arranged to slide, while as I translate the passage they were swung between two uprights. I have seen in a very old and poor house the remains of a grooved threshold and a broken bar above which might have supported a sliding door, but I have never seen any in use, nor can I find any *kamaaina* who have. Certainly a sliding door would be convenient in a house like that of the Hawaiians, but a hinge of coconut cord was simpler, and hence more likely to have first suggested itself to the primitive builders. I have also seen a pintle hinge used. We have seen that the Maori houses were provided with neat sliding doors, generally decorated with carving, but we cannot consider these primitive houses. The doors of matting—perhaps we should more properly call them curtains or screens—in Samoa were suspended so as to slide with some small latitude, but generally our information about such details as door hanging is pitifully scant.

The Hawaiians had a bar to fasten the door from within, which would indicate a swinging door, but they also had a contrivance to deter uninvited persons from entering at night, consisting of a heavy stone[55] suspended over the door by a rope which passed across the doorway, near the floor, in such a way that an intruder would trip it from a peg in one of the door posts. The weight of the stone (one in this Museum weighs 36.7 pounds) was sufficient to kill or at least disable one on whose back it fell. This man-trap would perhaps be most convenient with a sliding door, but could be so arranged as to be tripped by the act of opening a swinging door. When the family were absent the most secure way of fastening the door was by the *kapu*. The signs of this universally respected prohibition were various: two sticks crossed before a door, as in Fig. 86; stick with a tuft of white kapa or a white ball on the tip, planted on either side, were most usual; while a coconut tree or a bunch of bananas could be preserved from theft by a fillet of white kapa bound around it.

---

[55] A figure of one of these door stones is given in my account of Hawaiian Stone Implements, Memoirs, I, p. 351.

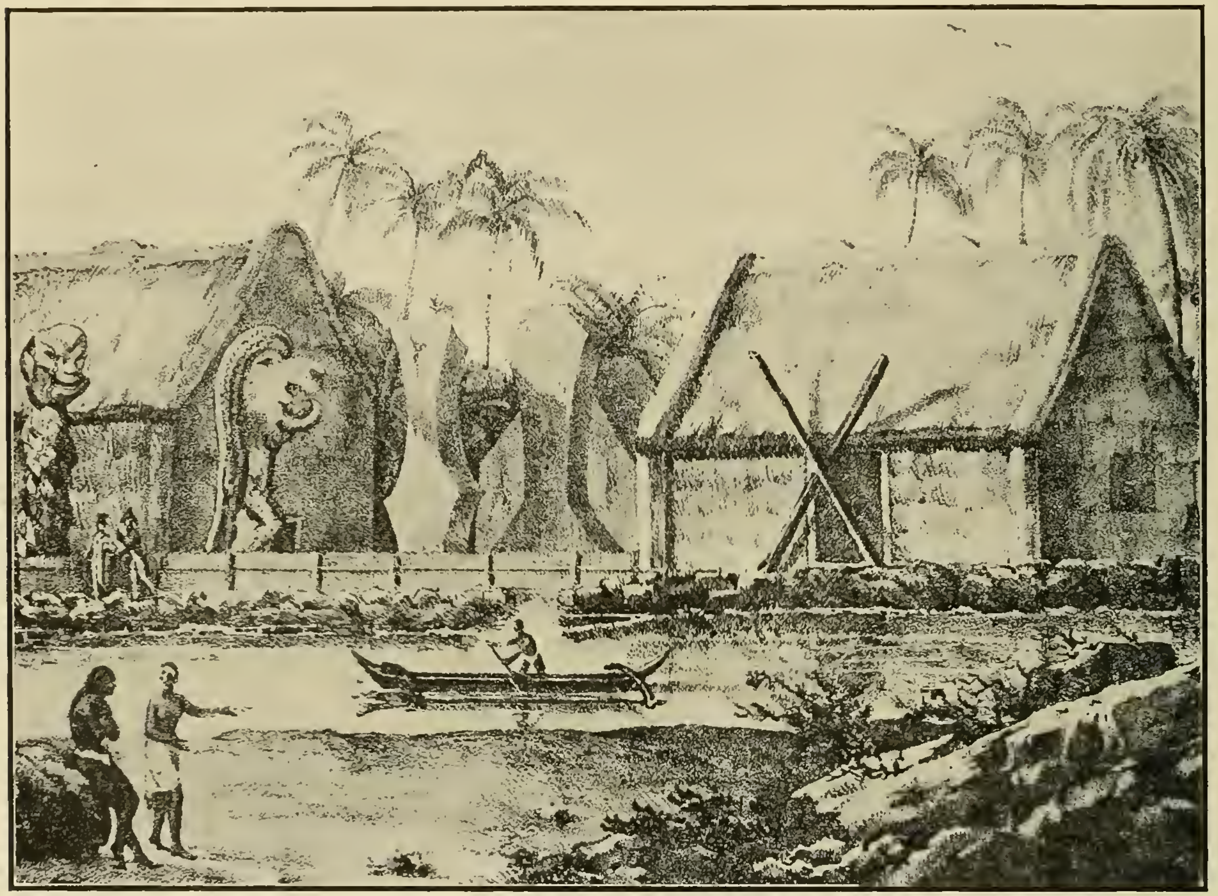


FIG. 86. SACRED HOUSE WITH THE KAPU SIGN ACROSS THE DOOR.

The floor when at its best was of small pebbles carefully leveled and covered with mats. Commoner were the floors of earth covered with dried grass which mats kept in place. Such were the floors of the early churches built for the missionaries, in one of which at Kalapana on the east coast of Hawaii, I have attended and taken part in the worship, while whole families, including pet dogs and pigs, rested on such mats, through the long service, which lasted from nine or ten in the morning until four in the afternoon. The congregation of that early day has passed away, people and missionary, and I am perhaps the sole survivor, for the church is now many feet below the surface of the sea from subsidence of the coast. If I remember rightly one of the Kailua churches on the same island had the same kind of floor as late as 1888.

A fence around the house so close that the intervening space could hardly be called a yard was an important part of a decent house. This was made of palings, or if the country afforded them, as was usually the case, stone laid in a low wall with steps opposite the door. Before describing the religious services necessary to the completion of a respectable dwelling we may read the account Stewart gives of the building at Lahaina, Maui, of the houses Keopuolani, the highest chief on the group, had ordered her men to build for the missionaries who had just arrived at the islands. Although it is much as already described in these pages, I quote it as confirming the previous account, and also because forty-four years afterward I occupied a room in the foreign-built and comfortable house that had taken the place of the rude grass houses, and learned from the venerable man, Dr. D. Baldwin, who then occupied the mission premises, much that has helped my later studies of Hawaiian things. Stewart writes (p. 188):

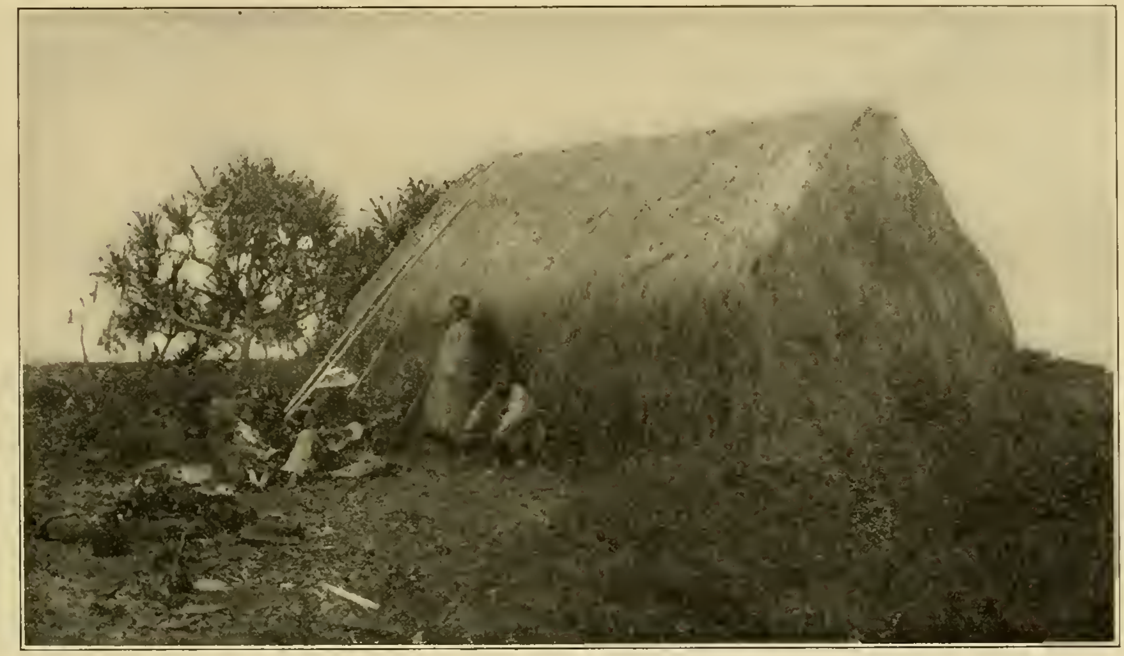


FIG. 87. GRASS HOUSE OF THE POORER SORT.

> The men began digging holes for the corner posts, making each house twenty-three feet long and fifteen feet wide, with a space of fifteen feet between them. The posts are about as thick as the

> arm of a man, and after being fastened in the ground are about five feet high. The whole number on each side of each of our houses is seven. The tops are excavated to admit a pole about an inch in diameter, which extends horizontally the whole length of the building, and to which the posts are all lashed with strings made from a small but strong vine [ieie?].
>
> The rafters are as numerous as the posts, and nearly as large, and are fastened to their tops with strings. The principal strength of the joint arises from an extension of the outside of the post, two or three inches above the larger and inner part, which is received into a corresponding notch made in the end of the rafters. The upper ends of the rafters rest on and are lashed to a ridge pole, supported at each end by a long post reaching from the ground to the peak of the roof. Between the corners and these middle posts there are others parallel to them diminishing in length according to the inclination of the roof. These complete the frame of the building. The next business is to prepare a foundation for the thatch. This is done by lashing small round sticks, at intervals of five or six inches, to the posts of the sides and ends, from the ground to the ridge pole; to these the thatch of grass is tied by strings made of the fibres of the cocoa-nut husk. In the best built houses, between the sticks and the grass, there is an inner thatch, or lining, of the leaves of the sugar-cane or banana.

The sequel must be told, and it is one that the small size of the house timbers should prepare us for.

> Native dwellings are objectionable in many respects. The wind, dust and rain find ready access to ours in every part; and not only put us to great inconvenience, but often greatly endanger our health. The leaves of the sugar-cane with which they are lined, and the grass and mats forming the floors, are secure and appropriate harbours for the mice, fleas and cockroaches which infest this land, and by which we are greatly annoyed.[56] But were the buildings ever so comfortable for the time being, their frailty would be an objection: the thatch must be frequently repaired, and the whole house entirely rebuilt every three or five years [p. 240].

Of the houses of Lahaina, Maui, Stewart writes (p. 182):

> The number of inhabitants is about two thousand five hundred. Their houses are generally not more than eight or ten feet long, six or eight broad, and from four to six feet high; having one small hole for a door which cannot be entered but by creeping, and is the only opening for the admission of light and air. They make little use of these dwellings, except to protect their food and clothing, and to sleep in during wet and cold weather; and most generally eat, sleep, and live in the open air, under the shade of a kou, or breadfruit tree.

Concerning the houses of Honolulu, then the more fashionable town, he has little that is complimentary to say:

> The houses of the chiefs are generally large, for the kind of building,—from forty to sixty feet in length, twenty or twenty-five in breadth, and eighteen or twenty in height to the peak of the roof [p. 137]. [See Fig. 93, p. 109.]

Of the *makaainana* or common people as distinct from the chiefs, and composing the bulk of the population he paints a sad-colored but true picture:

> The greatest wealth they can boast consists of a mat on which to sleep—a few folds of kapa to cover them—one calabash for water, and another for poi—a rude implement or two for the cultivation of the ground—and the implements used in their simple manufactures. Taro, potatoes, and

---

[56] Mosquitoes were not introduced until seven years after this was written.

> salt, with occasionally a fish, constitute their general food; while all else that they grow, or take, and every result of their labour, goes to meet the series of taxes levied by the king, and his governors, and their own respective chiefs.

Again (p. 152), on the beach south of the mission premises in Honolulu, he reports:

> The largest hut I passed was not higher than my waist: capable only of containing a family, like pigs in a sty, on a bed of dried grass, filled with fleas and vermin. Not a bush or shrub was to be seen around; or any appearance whatever of cultivation. It was the time of their evening repast, and most of the people were seated on the ground, eating poi surrounded by swarms of flies, and sharing their food with dogs, pigs, and ducks, who helped themselves freely from the dishes of their masters!

All accounts of the homes of the common people about the towns agree that at the time foreigners came to these islands after the voyage of Vancouver, the people were most wretchedly provided. In the country, and along the shores remote from town, the houses were cleaner and better built, if not much larger. I found, a dozen years ago, a few miles north of Kailua, Hawaii, a hut such as Stewart describes. An aged woman was sitting in it (she could not have stood up) and was busy scraping pandanus leaves for mats. She was reputed to be several years beyond the hundred mark.

The thatched house of a respectable man may not become a dwelling place until the *kahuna pule* or priest has blessed the work; a tuft of grass remains over the doorway which he must cut at the time of blessing. This ceremony did not take place until the house was furnished and the owner quite ready to move in; in some places, however, the priest was required to sleep a night in the new house before the owner, that all evil spirits might be thoroughly exorcised. I do not care here to enlarge upon this religious rite, as I hope to do that in another place, but I may be permitted to quote the two prayers given by Dr. Emerson in his notes to Malo, premising that there was no required formula, each priest using such expressions as the particular case might suggest. Thus, if the owner claimed descent from some god or demigod that being was referred to in compliment to the owner: or if the owner was a fisherman Kuula might properly be invoked to help bless the house, etc.

The priest stood at the door with all the friends and neighbors of the owner around in readiness for the feast that was to follow, and holding in one hand the stone adze, and in the other a block of wood, preferably a kapa beater or some other worthy domestic implement, chopped the grass when he came to the proper place in the prayer. This tuft shows over the centre of the door in Fig. 85. The tuft was called the *piko* or umbilicus of the house, and the whole ceremony *ka oki ana o ka piko o ka hale* or cutting the umbilical cord of the house. The Hawaiians observed peculiar ceremonies at their similar operation on the new-born child. Other peoples have also observed in their own way this marking the individual existence of the new life: to mention only one, the Maya of Central America cut the cord on an ear of maize with feasting and other signs of rejoicing. Like all recorded Hawaiian prayers they are interjectional and often difficult to translate—if, indeed, they have any meaning.

Ku lalani ka pule a ke oloalu i ke akua	In correct form is the prayer of the company to the god.
O Kuwa wahi'a i ke piko o ka hale o ——.	The Kuwa cuts the piko of the house of ——.
A ku! A wa! A moku ka piko.	He stands! He cuts! The piko is cut!
A moku! A moku iho la!	It is cut! It is cut down!
A moku ka piko i ele-ua, i ele-ao	Cut is the piko, the shedder of rain, shelter from
I ka wai i Haakula-manu la	the water of Haakula-manu, oh!
E moku!	Cut it!
A moku ka piko o kui hale la	Cut the piko of your house,
E Mauli-ola!	O Mauli-ola!
I ola i ka noho-hale,	Life to the house-dweller,
I ola i ke kanaka kipa mai,	Life to the guest,
I ola i ka haku-aina,	Life to the lord of the land,
I ola i na'lii.	Life to the chiefs,
Oia ke ola o kau hale e Mauli-ola;	Continue the life of your house, O Mauli-ola;
Ola a kolo-pupu, a haumaka-iole,	Life to advanced old age, till the eyes are dim,
A pala lau-hala, a ka i koko.	To the last stages of decay, till borne in a hammock.
Amama, ua noa.	The prayer is offered. It is free.

Some of the variations in the Hawaiian house may now claim our attention. In all the main structure was the same; stick and thatch, posts, plates, rafters and ridge-pole, but local or individual fancies or needs had their way and an old Hawaiian village was not always a confused cluster of hayricks. In the first place the pouhanà were often, in some places generally, inclined from the perpendicular either at one or both ends of the house, so that the ridge-pole that they supported was appreciably shorter than the distance between their bases. This was a disposition tending to strengthen the house frame, and the higher the house the more important such disposition. This form is shown in Fig. 90, and more definitely in a photograph taken in 1888 (Fig. 89), of an ancient house on the exact site of the priests' houses at the time of Cook's visit and death. This was between the shore and the sacred tank of the heiau where Cook was worshipped; it was deserted and seemed to have been so for some time, although the frame was sound, only the lashings were decayed. Dr. Ellis, the assistant surgeon of Cook's ships, gives us a picture of the houses that stood here a hundred years ago, Fig. 90, and I am inclined to believe that the frame may have belonged to one of these. Since the photograph was taken the house has disappeared.

It was not a great change, but a great advance, to break the pouhanà and the kukuna at the level of the lohelau or plate; carrying this completely around the house, thus strengthening the walls, and shortening the ridge-pole about one-half. The principals still supported the ridge-pole, and the lower portion of the post, set firmly in the ground, was able to resist the thrust which was distributed to the poukihi also by long corner rafters (see Plate XXVII). This form was called *puoa*. Houses built this way were somewhat lower than the older double-pitch roofed houses, and better suited to windy situations. This form was adopted by many of the early settlers, as most convenient when surrounded by a broad verandah.

Another early and exceedingly convenient addition to the common grass house in a land where the people lived so generally in the open air, was the lanai, shown well in Fig. 84: extensions of the rafters continued the roof forward at the same or a slightly reduced slope. This verandah was, generally speaking, the most comfortable part of the house. This lanai was often detached as in the Hale Kamani (Fig. 72), and was sometimes of great size with walls of atap or coconut leaves intertwined, and a nearly flat roof of similar substance which was intended to furnish shade rather than shelter from heavy rain.

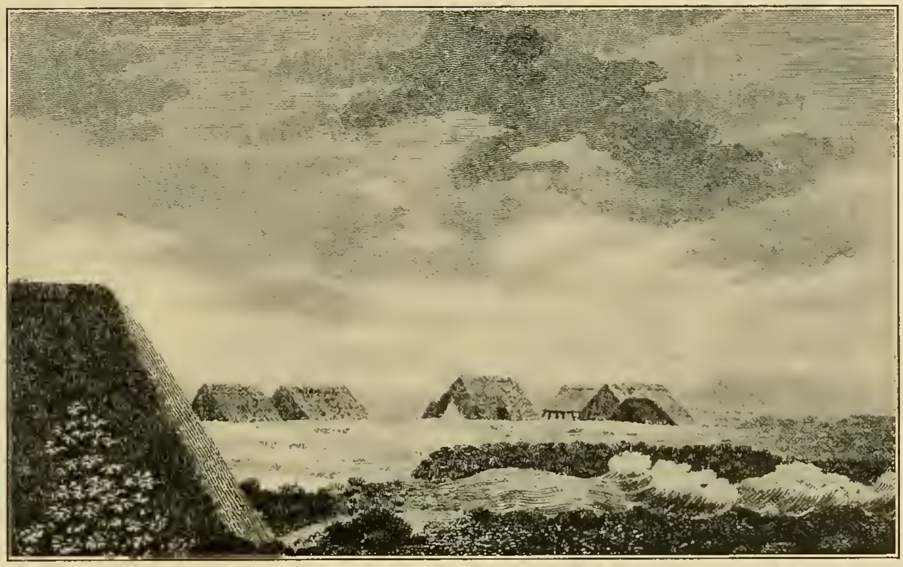


FIG. 88. HAWAIIAN VILLAGE ON NIIHAU: ELLIS.

These coconut leaves (for which in later times date palm leaves were a fair substitute) were often used as an outside sheathing to the walls, protecting the thatch in windy situations, but they never became the important house material that they have been and are in India and the East Indian Archipelago.

In the various accounts of the old Hawaiian houses there is no mention of any pent over the door in the sloping side. The Polynesians understood the importance of shielding the door of the house not only from the direct rain but especially from the

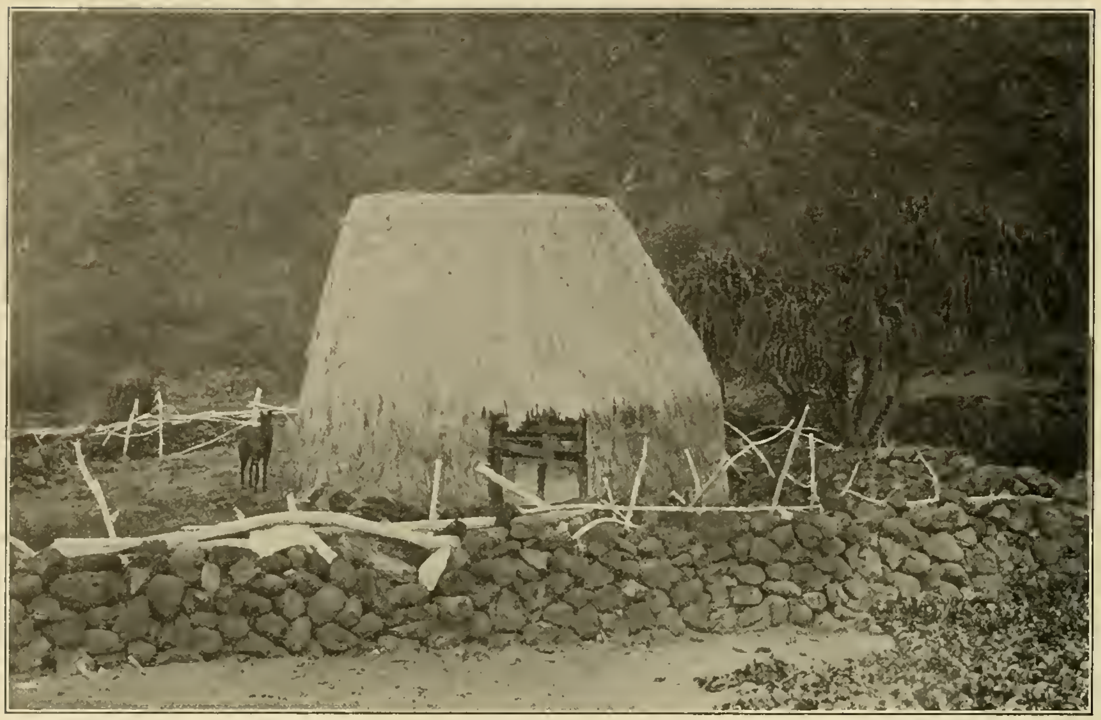


FIG. 89. HOUSE ON THE BEACH AT KEALAKEAKUA.

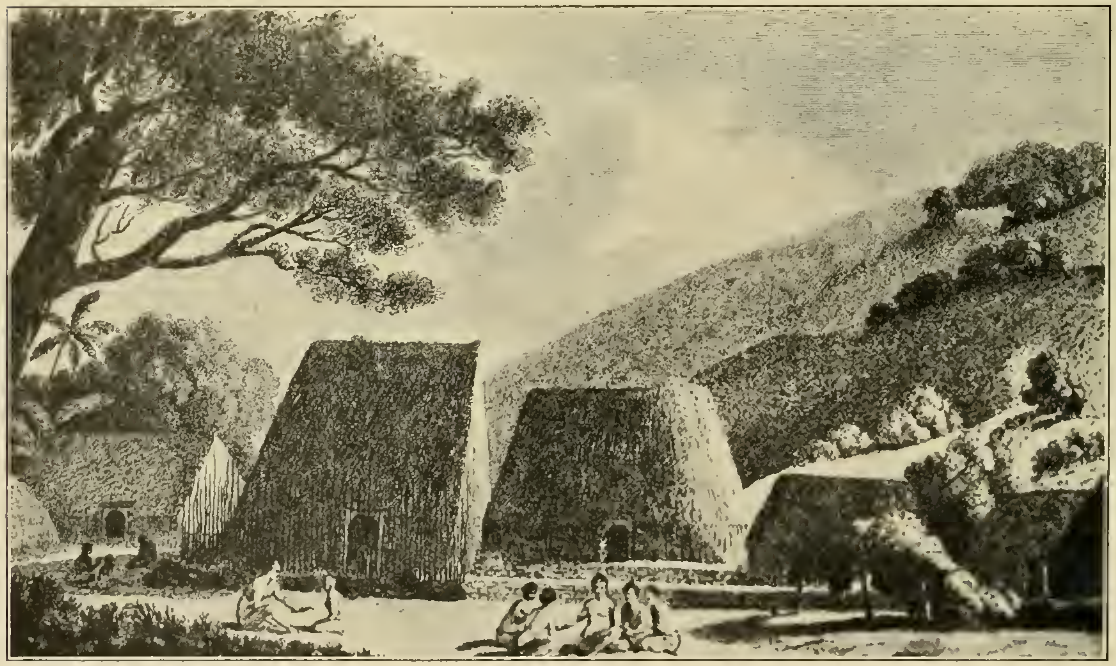


FIG. 90. ELLIS' VIEW OF HOUSES AT KEALAKEAKUA.

accumulated downpour of a steep roof. We have seen that the Fijian, even when his doorway was in the perpendicular wall, formed a pent of thick thatch (Fig. 21). The Maori at the other end of the ocean projected his gabled roof far over the door; but no notice was taken of the contrivance used by the Hawaiians on the sloping side of their house to keep the water from pouring in at every shower. One piece of evidence remains, a picture drawn by Dr. William Ellis (Fig. 91). In that he shows a projection almost a porch. As the steep-roofed grass house had disappeared before I came to these islands, I never saw even the ruins, and no one could tell me how the rain was kept out; in the time of Cook's visit, however, the picture was made which solves the enigma. The arch over the door is to be noticed as it again appears in the later houses of Kalaimoku on Oahu.

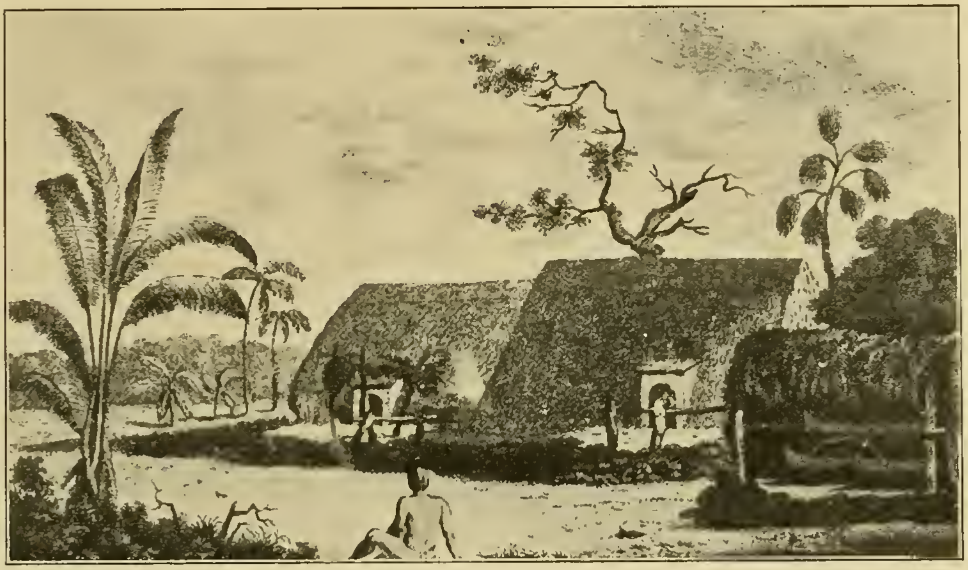


FIG. 91. VILLAGE ON HAWAII: W. ELLIS.

From the abundance of stone on many parts of the group one would expect some houses to be built with stone walls. The old Hawaiians had a tenacious earth, which they mixed with the ashes of some plants to make their salt pans water-tight, which would have answered well to bed the stone, and that they understood the use of this kind of mortar is proved by the walled-up entrances to ancient burial caves, where the earth matching the stone it holds in place, is found in order after the lapse of more, it may be, than a century. While I believe that this construction was among the earliest, I have no proof; and it was not until the early Christian churches were erected that I am sure of its use. The stone walls of the heathen temples, in more than one case, were converted into Christian churches by putting on a thatched roof. There was a similar church in Kona on the opposite side of Hawaii whose stone walls, built precisely as were the walls of the ancient heiau, toppled down in an earthquake in 1867. I am told[57] that there is a small village of stone-walled houses on Maui; they are surrounded with a thick growth of *Lantana* which shelters them.

How early the Hawaiians introduced adobe walls, I do not know; in the early days of missionary work here, the Chiefs' School was built of large adobe blocks and thatched: one of these blocks in good preservation is in the Museum. The well-worked mud of the native kalo patch might have early suggested the use of this material on the dry lee side of the islands. While there are reports of the use of mud to protect the thatch of the roof, this untidy method was apparently little used, still less was mud used to plaster the walls, as did the Micronesians on Kusaie, although there the material was lime mud or plaster. Of all the bizarre materials that the old Hawaiians used for walls, human bones were least appropriate or desirable. In the *Hale Iwi* (house of bones) at Moanalua were built the trophies of a bloody battle, but as new light dawned upon these people, the bones were quietly buried. Fornander gives a brief account of

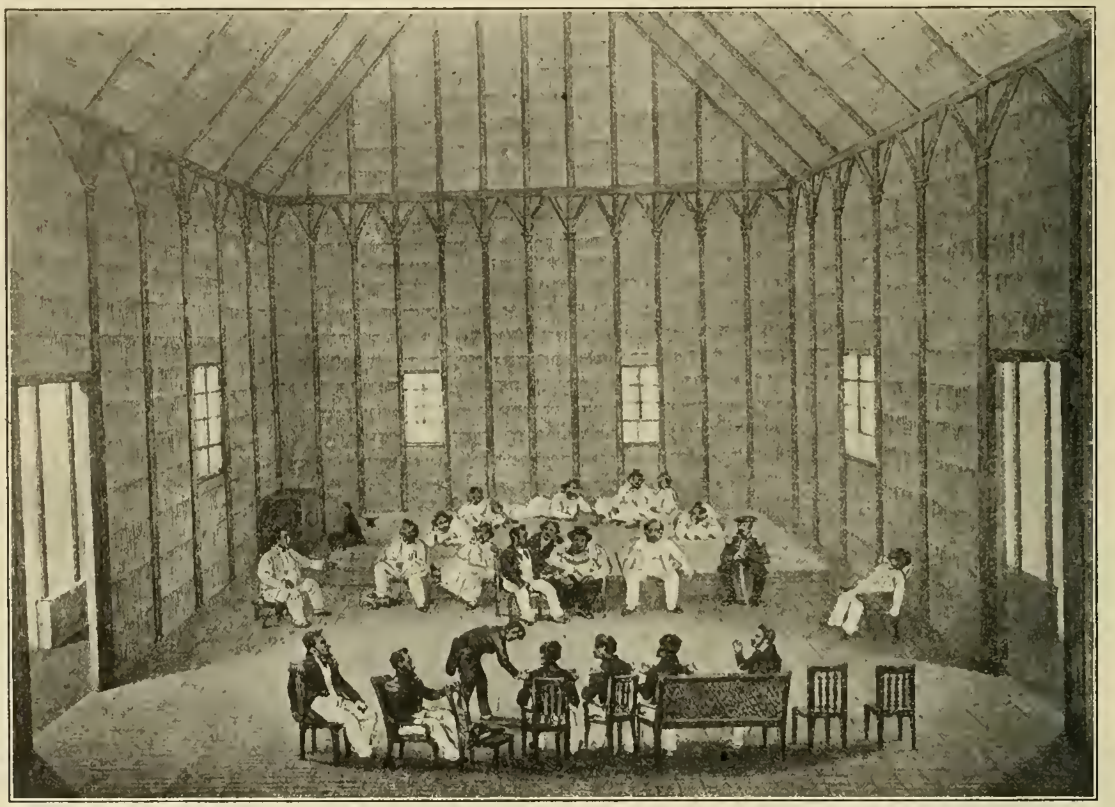


FIG. 92. HALE KAUILA IN HONOLULU.

---

[57] My authority is Dr. C. Montague Cooke of the Museum staff.

this house after describing the "Waipio Kimoku," and it is so illustrative of the times just preceding the coming of the white men as settlers rather than as explorers or traders that I quote it in full:[58]

> Fearfully did Kahekili avenge the death of Hueu on the revolted Oahu chiefs. Gathering his forces together, he overran the district of Kona and Ewa, and a war of extermination ensued. Men, women and children were killed without discrimination and without mercy. The streams of Makaho and Niuhelewai in Kona, and that of Hoaiai in Ewa, are said to have been literally choked with the corpses of the slain. The native Oahu aristocracy were almost entirely extirpated. It is related that one of the Maui chiefs, named Kalaikoa, caused the bones of the slain to be scraped and cleaned, and that the quantity collected was so great that he built a house for himself, the walls of which were laid up entirely of the skeletons of the slain. The skulls of Elani, Konamanu, and Kalakioonui adorned the portals of this horrible house. The house was called "Kauwalua" and was situated at Lapukea in Moanalua, as one passes by the old upper road to Ewa. The site is still pointed out, but the bones have received burial.

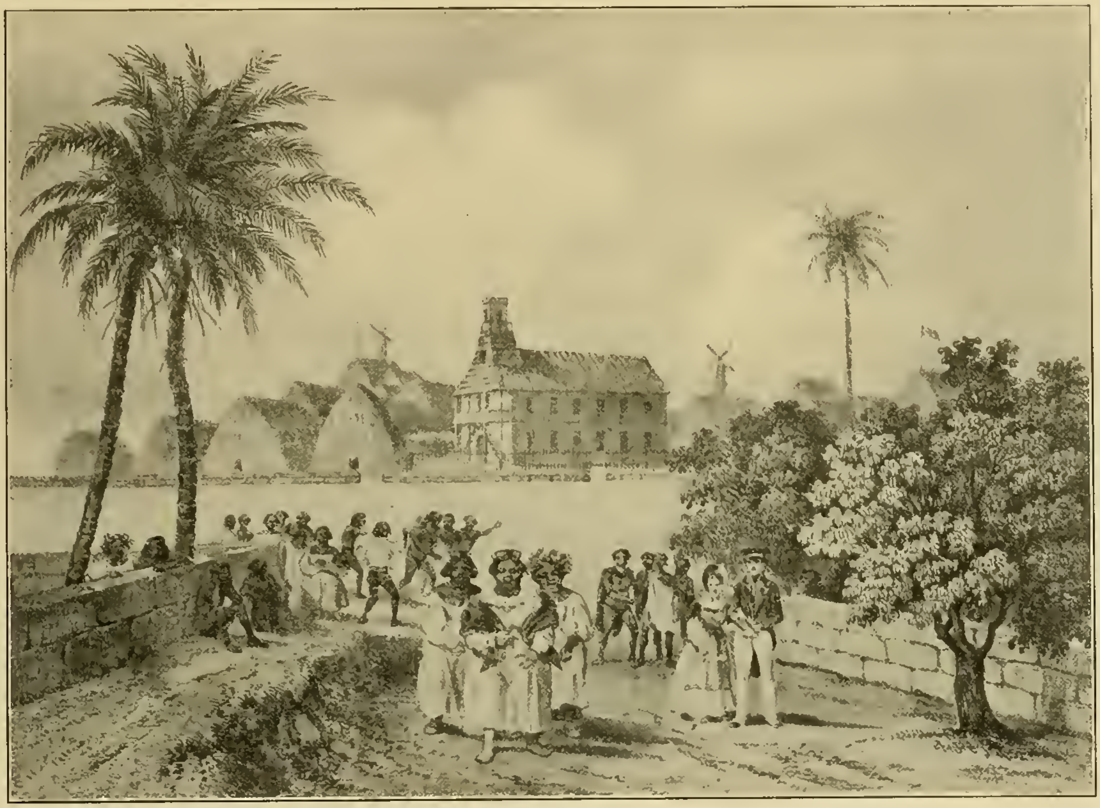


FIG. 93. STREET VIEW IN HONOLULU, WITH KINAU IN THE FOREGROUND: 1837.

We come now to the transition period when the foreign influence and example were felt in the native habitations: and we find that native and foreign patterns were mutual influences, and first we will consider the foreign ways and ideas adopted by the natives. The introduction of higher doors was perhaps the first and most general innovation; next came the windows, whether mere *puka makani*, openings without glass only for ventilation, and these had been known although not generally used long before, or the new *puka aniani* or windows of glass, certainly a wholly foreign introduction Next, perhaps, were wooden floors and partitions within the house. After that the house ceased to be native. We have several illustrations of this changing style: first, the *Hale Kauila* (house built of kauila wood) which once stood on the street in Honolulu which still bears the name of this large council chamber or reception room (Fig. 92). It will be seen from the illustration that while the thatch is attached in the usual way, the pou or posts are much higher than usual and of squared timber; but the most foreign touch, apart from the windows, are the cross braces at the top and between the posts and the plate. It is true that they are too short to greatly stiffen the frame, but they were never used in genuine native work. The scene is characteristic of the time (July, 1837), I will quote the description by Captain du Petit-Thouars of this house (which he calls the house of the Queen Kinau). It must be remembered that the French officer had come to Honolulu to reinstate the Romish priests who had been banished by the native government, and had been joined by Captain Belcher of the Sulphur who was in port at the same time, and the notorious Charlton, British Consul, and Jones the American Consul, none of them friends of the American Mission, and

---

[58] The Polynesian Race, II, 226.

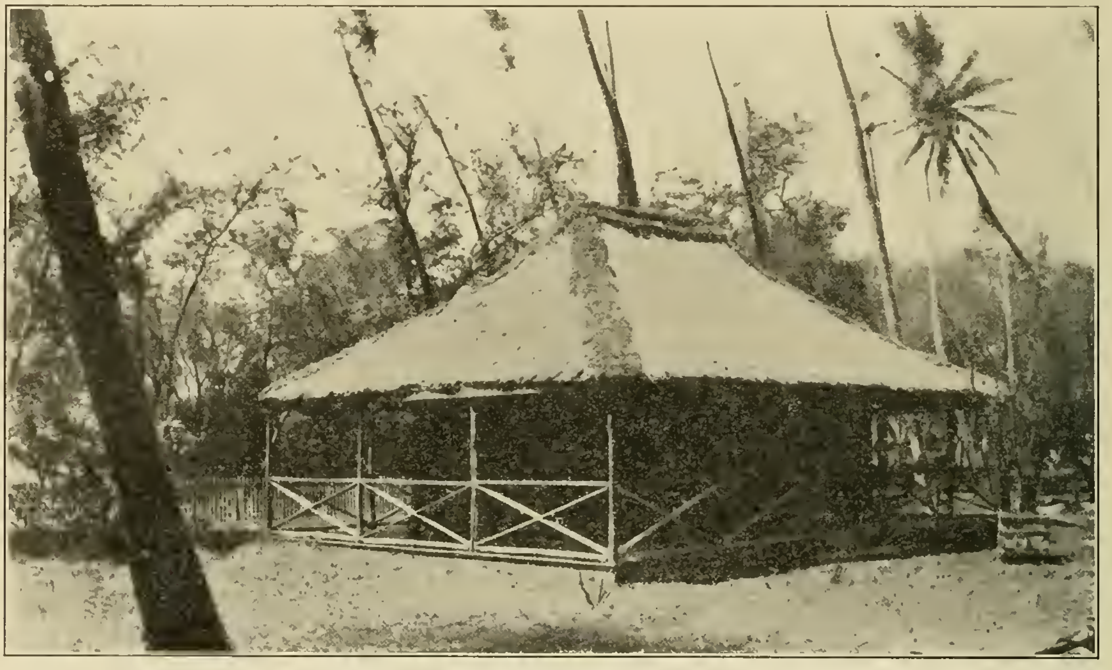


FIG. 94. HOUSE OF KAMEHAMEHA V AT WAIKIKI. HALE LAMA.

the French officer piqued by the firm bearing of Kinau, and the general indifference of the natives could claim only these three unfriends of the Hawaiians and their American teachers, so his views of Honolulu are not always agreeable:

> La case de la reine, dans laquelle nous eûmes nos conférences avec les chefs, est une des plus belles ; elle est située à l'E., sous les murs du fort, et auprès du bord de la mer. Cette maison, bâtie en bois et couverte d'herbes sèches, est placée au milieu d'une enciente fermée d'une palissade. La plate-forme sur laquelle elle repose est élevée au dessus du sol de la cour d'environ 30 centimètres et elle est entourée, extérieurment, d'une galerie couverte qui la rend plus agréable.

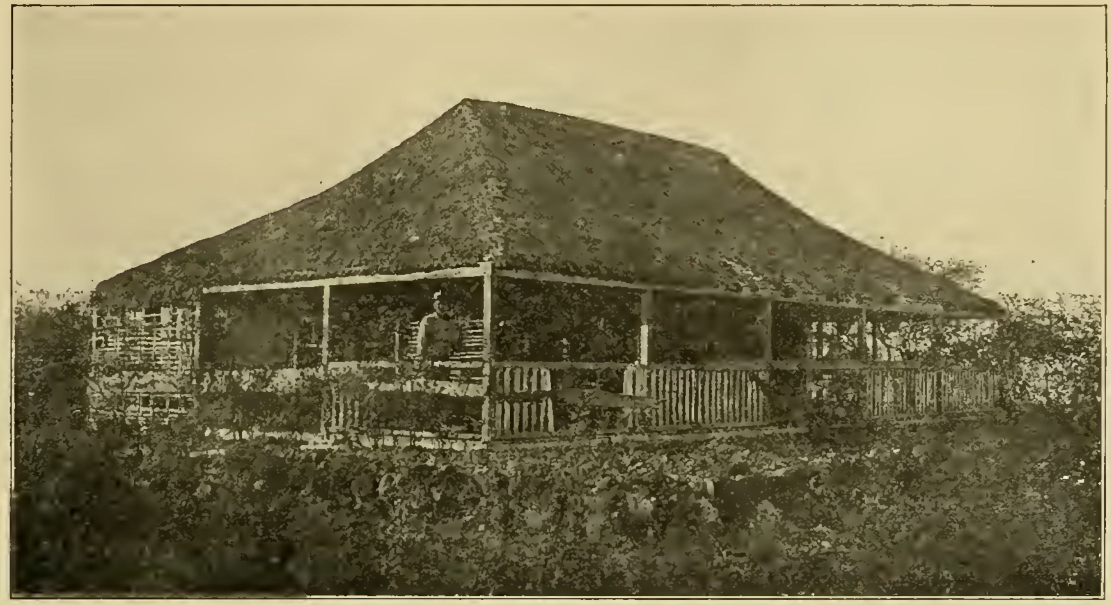


FIG. 95. HOUSE OF KAMEHAMEHA V AT KAUNAKAKAI.

> Sa forme à l'intérieur, est celle d'une rectangle allongé ; dans l'un des bouts, il y a un appartement formé par une cloison en planches qui ne s'élève pas jusqu'au toit. Cette pièce sert de chambre à coucher ; dans le reste de l'aire de la case, et à l'autre extrémité, il y a une portion du sol élevée de 28 à 30 centimètres, qui est recouverte de plusieurs nattes : c'est sur cette espèce de grand divan que se placent les dames ; elles s'y tiennent couchées sur un côté ou sur le ventre : c'est ainsi qu'elles reçoivent et se tiennent pour causer et faire salon.[59]

Present at this conference were the King, Kauikeaouli, his sister Nahienaena, and wife, Kalama, Kuakini (who is asleep in the chair?), Hoapili, Boki and his wife Liliha, Kinau and other chiefs. M. du Petit-Thouars assures us in a note (p. 336) that the figures are fair likenesses.

One of the royal grass houses of the Kamehamehas is still preserved at Waikiki, a suburb of Honolulu. The foreign influence is shown in the surrounding verandah and railing. The walls next the verandah are of grass as is the roof: unfortunately in the illustration, Fig. 94, the shadow of the roof conceals the nature of the walls while showing the reflection of light from the smooth stems of the grass.

---

[59] Voyage autour du Monde, sur la Frégate La Venus pendant les années 1836–1839 par Abel du Petit-Thouars. Paris, 1840. I, 384.

The next step is seen in the house built for Kamehameha V at Kaunakakai, on the south shore of Molokai. When the photograph was taken in 1888 the house was in ruin and quite uninhabitable; were it not for the bars across the lanai openings, cattle might have entered this deserted fishing lodge of the king who, like all his family, was so fond of fishing that he often deserted his court in Honolulu and was paddled to this place where he remained for weeks at a time, out of the reach of the foreigners whom he liked none too well. The enclosed corner of the lanai or verandah was very foreign, however, and so were the partitions found within the house.

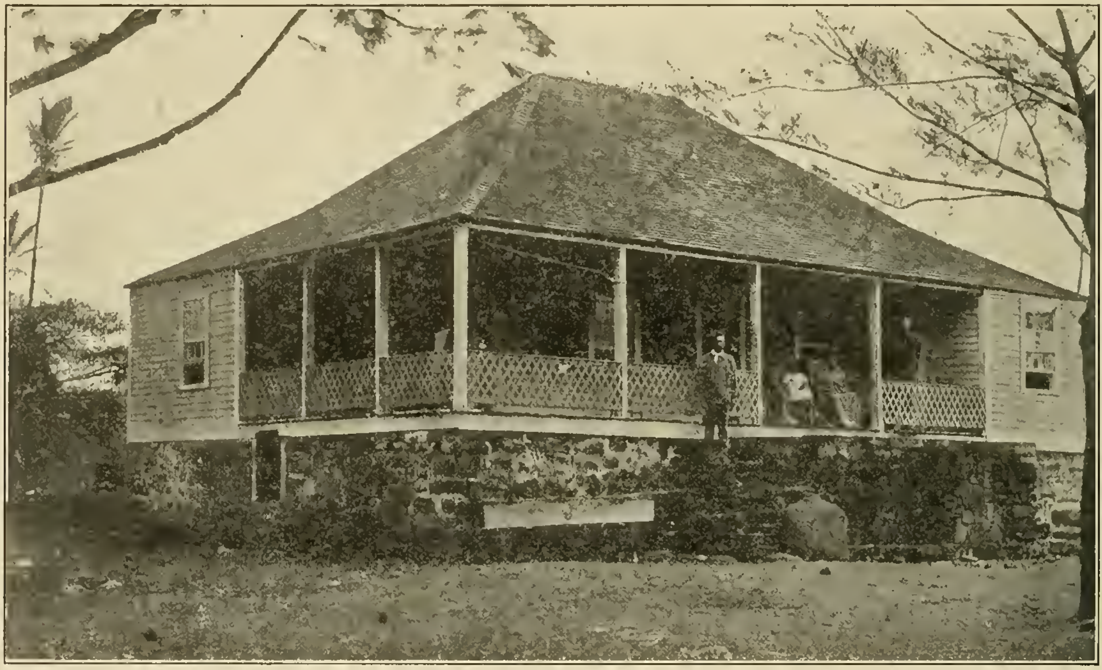


FIG. 96. HOUSE AT KAIMU, HAWAII, IN 1888.

The third picture, Fig. 96, shows a native house converted into a full foreign model: doors, windows, separate rooms, and cellar, a model often used on ranches and in country houses or on the outskirts of Honolulu, most comfortable and suited to the climate.

The only other way in which the Hawaiian dwelling has influenced the foreign house is perhaps in the large lanai found in many houses and used both as a dining room and a general reception room. This lanai is generally open on one or two sides, and in the pleasant climate of these islands is the most agreeable room in the house; it is all the time a stiff model of the old Hawaiian lanai of palm-leaf or grass roof and perhaps a slight wall of similar material on the windward side.

It has been mentioned that the *lama* wood was especially that used for building houses for the gods, that is, the thatched houses within the enclosure of the *heiau* or *luakini* (temple), and its use in building the house for King Lot, Kamehameha V (Fig. 94), gave an excuse for its reported use by an old kahuna (priest) in the king's establishment, for a house of prayer, and I am assured by an old resident that prayers to the gods were frequently offered therein.

Another example of the old Hawaiian building modified by foreign needs is seen in the old Volcano House on the brink of the crater of Kilauea. When this was built for the accomodation of visitors to this which is perhaps the most attractive volcano on earth, access was difficult; the long trail, nearly thirty miles from Hilo, was bad and consumed a long day in the horseback ride. To get foreign material for even a small hotel to this place was very difficult, and recourse was had to the native methods of building to a considerable extent. When the present comfortable hotel was built, after a cart road had been opened from Punaluu, the old house was incorporated with it. In process of modernization the lanai was widened and indeed rebuilt, and the old posts were found to be of hewn naio (bastard sandalwood). It was originally built largely by natives who had their *hale pili* scattered here and there through the region, and made a living by picking *pulu*, an obsolete article of commerce.

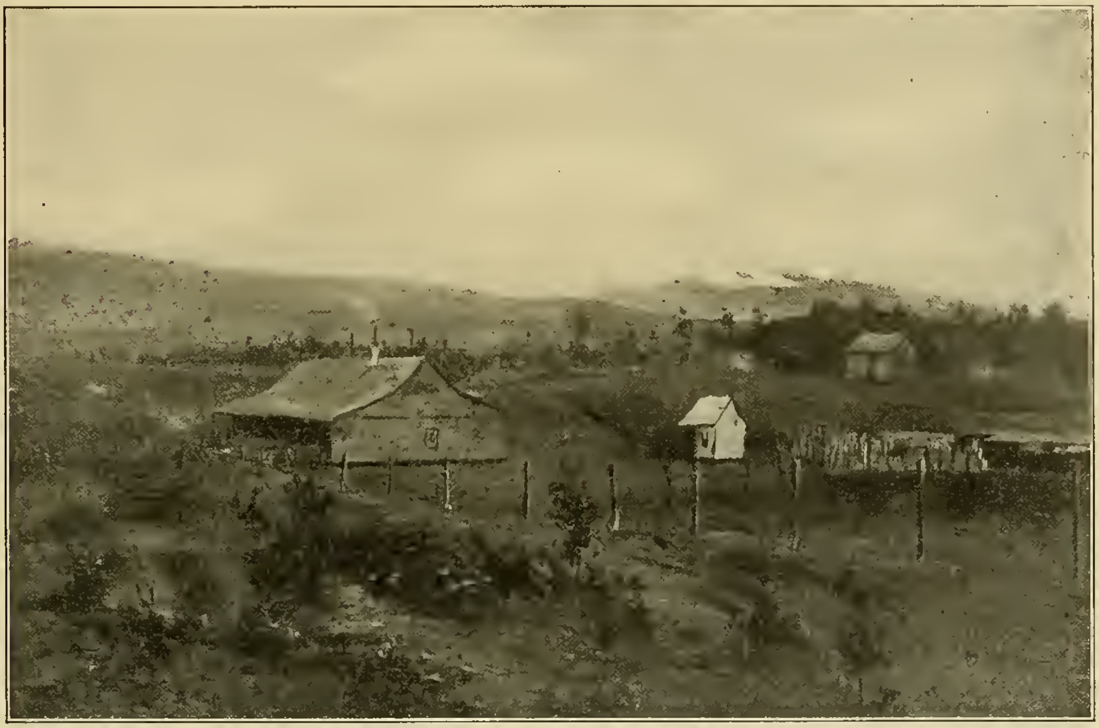


FIG. 97. OLD VOLCANO HOUSE: PAINTED BY HOWARD HITCHCOCK.

Hawaiian Fireplace.—I have left to the last the fireplace which was found in most of the ancient houses. In the colder regions where hunting birds or making adzes compelled some of the natives to dwell for a season, fire was a necessity in the sleeping place, and in the mountain region I have experienced the comfort of the fireplace filled with glowing embers, and although the house had no chimney nor other opening than the ordinary door, there was, to my surprise no trouble from smoke, as the door was left open during the night. In the centre, usually, of the house, and so opposite the door was a shallow excavation walled in with flat stones set edgewise, or sometimes where such stones were not at hand, with larger and wider stones firmly planted as a rectangular wall perhaps eighteen by twenty-four inches. This fireplace was not intended for cooking, which was done out of doors and in an *imu* or buried oven (which belongs properly to the chapter on Food and Cookery).

The fire was kindled carefully and during the night was often replenished by any one who happened to be awake, and in a large company there was sure to be some one awake at any time of night. If a proper selection of wood was made there was little smoke. Often one sees in the stone kahua or platform that marks the site of a vanished house the neatly built fireplace, the last fire quenched so long ago that it differs little in color from the other stone of the ruin.

I do not think the Hawaiian, like his Maori brother, ever cut the fireplace from a single block of stone (see Fig. 32); perhaps there was no stone so well suited for the purpose as is found in New Zealand; nor did he shut himself in with his fire until the heat was almost overpowering; but then his climate never was so chilly as that of southern New Zealand. When the old writers commiserate the ancient Hawaiians for having houses with no outlet for the smoke and vapors of their fire except the low door, it is probable that they never spent a night in such a house with a fire. In modern times, since the introduction of tobacco, the grass house certainly becomes stifling to a nonsmoker even near the open door, for the wild tobacco emits a stench that no island wood could equal. We must now look at the kindling of the fire, although that perhaps should come after the house is fully furnished and occupied, and so be relegated to the third part of this chapter. I will, however, confess to having caught somewhat of the disorderly method of the Hawaiian raconteur, and must plead that if every description is not in logical sequence.

Firemaking.—The Hawaiian, like other Polynesians, made fire by ploughing, not by drilling, although they had the pump drill in very early times. If the first immigrants to the Pacific islands came from Asia they passed through a region where fire drilling was generally practised from Australia to Japan, and as in the case of the loom they "passed by on the other side." If they came from the American continent that also was a land where before the coming of the white man the fire drill was universally used.

With the curious disdain the Hawaiian seems to feel for the works, processes or results of his forebears in heathen times, one cannot be surprised at the utter forgetfulness that has fallen on the modern representatives of this great Polynesian family so annoying when the archæologist tries to resuscitate old customs. Almost as soon as a matchbox could be obtained the ancient implements of firemaking which had well served countless generations were consigned to the limbo of useless things, and their very names soon erased from memory. Names that were obtained more than half a century ago and embalmed in print are the only relics of many a useful and to us interesting process in the daily life of the primitive settlers in the Pacific. I have seen old Hawaiians who worked for Kamehameha the Great make fire at my request, but as the present generation is ignorant of these matters and not eager to be photographed doing such "old fashioned things" I turn to their kin in New Zealand for an illustration (Fig. 98) of the old Hawaiian method of making fire: it was done on

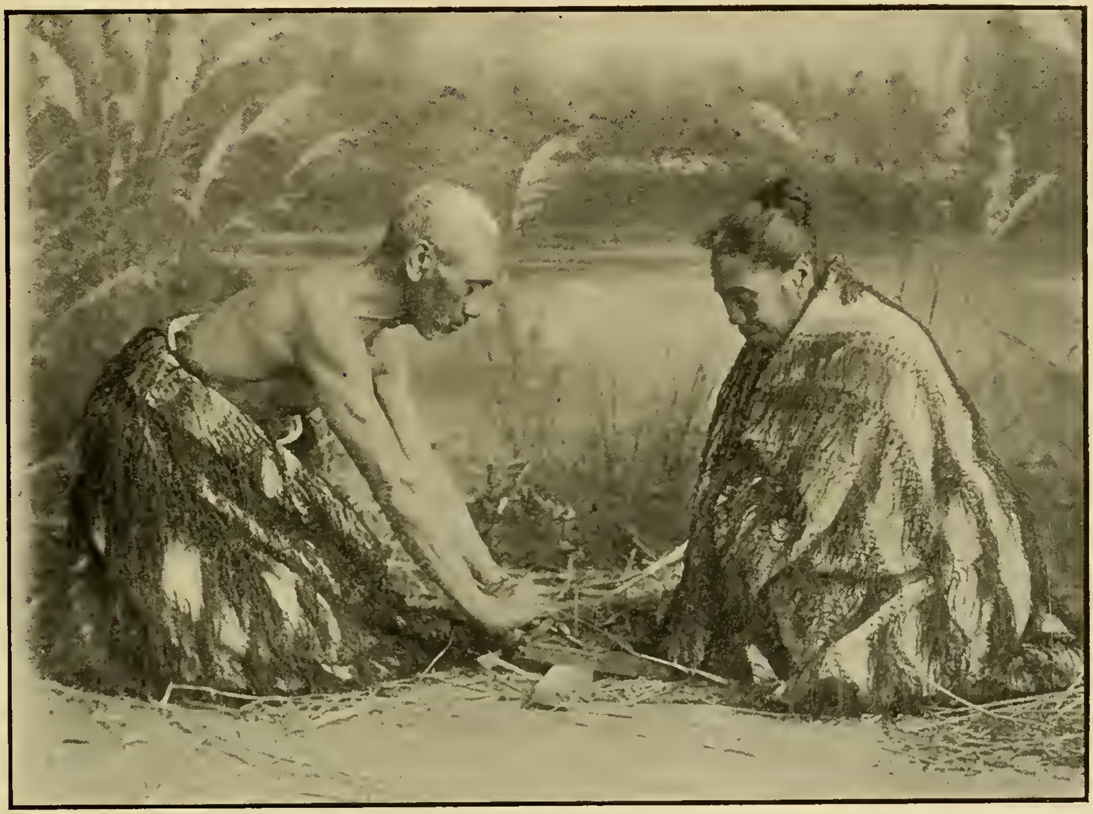


FIG. 98. MAORI FIRE MAKING.

Hawaii precisely as the Maori and his wife are represented doing at the present day in the native villages of New Zealand.[59]

The tools used by the old Hawaiians were a stick of dry, soft wood (*hau* was commonly used), of such size as to be conveniently held between the feet or by another person; and a much smaller stick of hard wood held in the hand and moved rapidly and with force to and fro in a groove on the soft stick called *aunaki* (in Maori *kauahi*), and the harder wood plow *aulima* (in Maori *kaurimarima*).[60] With a few rubs the friction is sufficient to char the wood and in about a minute the dust that collects in the bottom of the groove ignites and the flame is dexterously caught on a bit of tinder or a *welu ahi* (No. 4247, Fig. 99), composed of twisted or braided kapa: this also serves for slow match. The *ohe puhi ahi* (No. 166, Fig. 99), a joint of slender bambu, served to blow the fire when kindling.[61] With volcanic fire perpetually burning on the largest island of the group, and traditionally the one

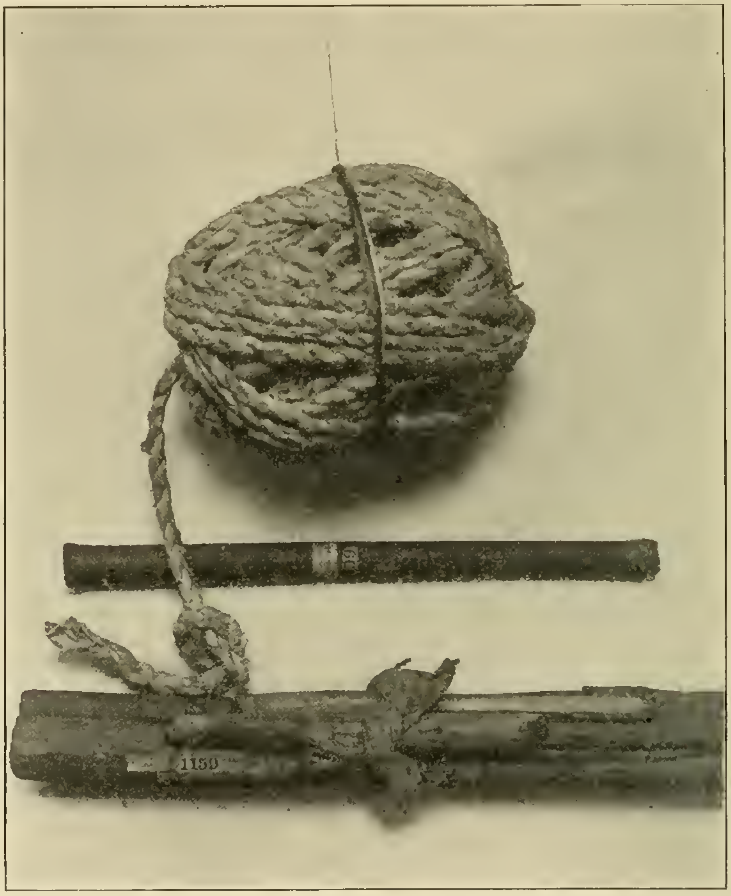


FIG. 99. HAWAIIAN FIRE MAKING TOOLS: IN BISHOP MUSEUM.

---

[59] This pair of Urimera Maori was a most interesting antique and fully imbued with the ancient ways and spirit of the old New Zealander. When they visited the white man's town for the first time they showed almost the stoicism of the Amerind at the sight of great novelties, and their comments were often quaint and amusing. The woman thought the white folks must be fools to build one house on top of another when land was abundant!

[60] There is more than a passing interest in the comparison of the words used to designate these fire-sticks in Hawaiian and other Polynesian dialects. *Aulima*, *au* a handle (also the motion of the hand in mixing poi), *lima* the hand (also the numeral five from the number of fingers); in Maori *kaurimarima* (l and r often interchangeable in Polynesian words); Tahitian *aurima;* Mangarevan *kourima*. The lower piece is named in Maori *kauahi* or *kaunoti*, in Tahitian *auai*, Mangarevan *kaunali*. As to the Maori *kaurimarima*, Mr. Edward Tregear remarks in his Maori-Polynesian Comparative Dictionary *sub voce*, "This is probably the only Maori word in which *rima* is used for 'hand', although *rima* [or *lima*] is 'hand' or 'five' almost everywhere else in Polynesia." The motion of rubbing is *hia* in Hawaiian.

[61] It is not necessary to go farther into the process of firemaking by two sticks, as this has been already well done by Dr. Walter Hough in the report of the U. S. National Museum for 1888; but in that paper Mr. R. Brough Smythe is quoted as attributing the use of the fire-plow to all Australians; the drill was more widely used on the Australian continent.

where the immigrants first landed, and with eruptions every few years that nightly brightened Hawaii and the nearer islands for weeks and even months, it is strange that the legends of the origin of fire trace it, not to the redoubtable Pele, goddess of the volcano, but to the humble water-hen (*alae* of the natives) who alone knew how to make fire and long refused to impart the secret to human beings. At last one day the inevitable happened and a man came upon one of these birds who had been warming itself by its manufactured fire. As usual, the bird refused to tell whence came the comfortable blaze, so the human featherless biped seized the plumed one and pressing a still glowing brand from the fire against the forehead of the bird held it there until in its agony the poor wretch gave up its secret in fragmentary shrieks, and as an irrefragable proof of the truth of the legend the forehead of the bird is still red.

The flint and steel of our ancestors were not more efficient than the simple fire-sticks. No flint was found on the Hawaiian group, nor metallic iron, but the compact clinkstone and the hard iron oxide or hæmatite are claimed to have been used by the natives; never so popular as the aulima and aunaki. The application of fire to light rather than to heat will be discussed later with the torches, candles and lamps; but the clear burning embers in the fireplace gave a dim but sufficient light that did not hinder sleep, but showed the indistinct figures moving from their lair to the door or returning without disturbance to their rest; and when the fire-tender put new fuel on the embers the temporary flash disclosed a scene to be remembered.

That I might be sure of the names given to the house parts in olden times I printed a list, which I give below, of words and their definitions as given by Andrews[62] in his dictionary, to be submitted in whole or in part to various old Hawaiians met in the circuit of Hawaii; but the results were not encouraging and but little new was added to the list. Such as it is I offer it here as a convenience to any reader who needs such a vocabulary.

VOCABULARY OF TERMS USED IN HOUSEBUILDING.

Aaa. A humble dwelling; also an uninhabited house (an egg shell).

Aaho. Same as aho.

Aha. To stretch the cord by which the first posts of a house were located.

Aho. Small, straight sticks used in thatching. Aaho seems a corruption.

Aina (hale). A house for eating; he hale aina oia kekahi.

Ako. To thatch; ua akoia ka hale.

Aualo (halau). A shed for storing canoes or other bulky articles; front of house.

---

[63] A Dictionary of the Hawaiian Language, by Lorrin Andrews. Honolulu, 1865.

Auau. Name of a certain *aho* to be thatched first in building a heiau.

Auolo = aualo. A shanty.

Auha. A shed to screen canoes from the sun.

Auwae. (Chin.) The projection near the top of a post to hold the lashings.

Auwaha. The fork at the lower end of a rafter.

Hakala. The gable end of a house; the side of a house.

Halau. Long canoe house; eating house for men.

Hale. A house. The six houses considered proper for an ancient householder were:

1. *Heiau*, a chapel where personal idols were kept, and private worship held; this did not require the services of a priest.
2. *Mua*, the eating house for the men, *kapu* to women.
3. *Noa*, where the wife lived, not *kapu* to the husband.
4. *Hale aina*, the eating house of the wife.
5. *Kua*, also *kuku*, where kapa was beaten in bad weather; usually outside.
6. *Pea*, where the wife lived during the period of uncleanness.

Hale alii. A palace.

Hale hau. A house for the gods, made of hau (*Paritium tiliaceum*).

Hale halawai. A meeting house, or council chamber.

Hale kamala. A temporary structure.

Hale koko. House where the *hoalii* slept.

Hale kupapau. A sepulchre, house of the dead.

Hale lalalaau. A structure of the branches of trees, a camp.

Hale malu. A cool or shady porch.

Hale moe. A bed chamber or house for sleeping.

Hale papaa. A storehouse.

Hale poki. A house where the bones of a king were supposed to be deposited. Many other names of houses were used to express foreign ideas, especially in the translation of the scriptures.

Halii. To spread a net over a newly thatched house to keep the grass smooth while drying (Fig. 85); to put down mats after house cleaning.

Hana. Middle post of the end of a house; *pou hana*.

Hio. The corners of a grass house.

Hoaho. To twist strings for a house; to tie aho to a house frame; also hooaho.

Hoaka. A lintel.

Hoopoheoheo. To make a neck on the top of a rafter (Fig. 77).

Hui. The smaller sticks between posts and rafters, and parallel with them.

Kahua. A foundation or platform on which a house is built.

Kala. The ends of a house as distinguished from the front and back.

Kaola. A beam across rafters; a bar for a door.

Kauhale. A collection of houses; a village.

Kauhilo. To bind together the sticks of a house with a rope during construction.

Kauhuhu. The ridgepole.

Kaula. The plate or beam uniting the tops of posts; a rope.

Kaupaku. The upper ridgepole.

Kihi. Outside corner of a house.

Kipaepae. Stone steps; often of hammered stone; usually of the stone built into the *kahua* or platform.

Kamo hale. To dedicate a house.

Kuahui. A scaffold used during building.

Kuene. To measure out the foundation and posts of a house; to set up and tie together the frame; to take down a house and put it up elsewhere.

Kuenehale. A man skilled in house building.

Kukuna. End posts of a house; side posts of a door.

Kulana. Sides of a house.

Kuono. Inside corners of a house.

Laauku. An upright post.

Lala. The four corners of a house; thatch over the door after it has been cut.

Lanai. An open shed; a piazza.

Lapauila. Side posts for a door.

Lio. The tie beam of a house; a carpenter's horse.

Loha. Trimmings on ridges and corners of a thatched house.

Lohelau. Plate to which rafters are fastened.

Lole. To thatch a house smoothly.

Lolelau. The art of thatching a house.

Oa. Rafter of a house (Figs. 77–80).

Olokea. Scaffold used in building a house.

Pahale. The space around a house enclosed by a fence.

Paia. Sides or walls of a house.

Paihale. To thatch houses.

Paku. A partition; the wall of a small enclosure.

Palaau. A fence of sticks.

Palepo. An adobe wall; literally mud hardened.

Pani. To close; hence, a door or shutter.

Panipuka. A door.

Papaa. A storing; hale papaa, a storehouse.

Papahehe. A floor; not necessarily more than a smooth surface.

Papai. A screen; a slight house or shed.

Papai. To thatch, because in the process the Hawaiian, in drawing the cord tight around a bundle of grass, strikes it with the left hand.

Pili. Grass preferred for thatching; *Heteropogon contortus.*

Pou. Side posts of a house (Figs. 73–75).

Pou o manu. Post under which was the human sacrifice.

Pueo. Cords tied around posts of a house during building.

Puka. A doorway; also puka hale.

Puka makani. A ventilator or wind sail.

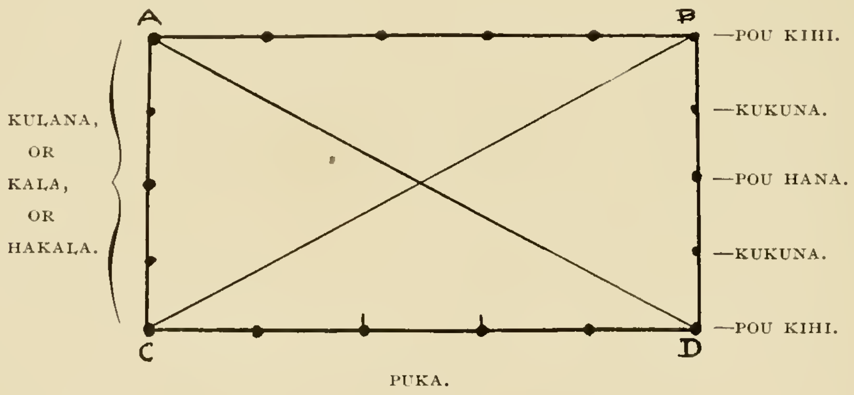
Puoa. A house built with the side poles united at top; a steeple.

Pupupu. A small or temporary house.

Wa. The space between two posts or rafters.

Waha. Fork in lower end of a rafter (Fig. 78). Same as auwaha.

Wekiu. The top of a house.



House Belongings: The Furniture of a House.

Here is the Hawaiian house, plain, no ornament, seldom a garden around it, none,—not even a trace,—of the elaborate carving of the Maori, nor the fantastic roof-work of the New Guinea or Solomon Islanders, a shelter surely but not yet a home, and that long distance between house and home so well known to the Anglo-Saxon is wonderfully shortened here in the tropics. Yet the Hawaiian recognizes the difference: the empty house, however convenient, however well built, has something dismal, even uncanny, and the belief of the untutored Carib, derided by the thoughtless, is natural and reasonable. He thinks that an unfinished house,—unfinished until it is inhabited by articles of domestic use, if not by human beings, is the chosen retreat of the devil, and the builders when they leave their work each night, place a simple wooden cross at the door and window openings. The devil is easier to keep out than to get out!

Centuries ago among the hills of Palestine, we get a glimpse of the same belief. "Then he saith, I will return into my house whence I came out; and when he is come, he findeth it *empty*, swept and garnished. Then goeth he and taketh with himself seven other spirits more evil than himself, and they enter in and dwell there."

Something of the same feeling prevails among the Polynesians, and the consecration ceremonies held before a new house is occupied always, I think, include a prayer that the evil spirits that may have entered the empty house, may be forever banished by the happy human life about to dwell in it.

We have seen the Hawaiian cut the last tuft of grass on the thatch, over the door-lintel and that bit of grass was symbolic not merely of the last touch of the builder, but a warning to any evil-disposed *akua* to keep out. When that tuft was cut and the kahuna had asked the blessing of the gods, the great gods and the lesser gods and the whole forty thousand gods, the owner and his family entered in with their belongings: a good and happy family is the best talisman, I know of, to keep evil spirits (or thoughts) at a distance.

We consulted David Malo in the building of the house and we may do the same in the furnishing, but the picture he gives us is not wholly a pleasant one, and we may suspect that he, perhaps unconsciously, contrasts the former state of his country-men with that newer civilization then knocking at the door. We know that in the houses of the alii there were, even in remote days, many things he takes no notice of in his brief story, and after his account we may turn to other sources of information.

EXTRACTS FROM CHAPTER XXXIII OF MALO'S ANTIQUITIES.

20. Oo ka ipu kekahi mea e pono ai maloko olaila e hahao ai ka ai, ka ia o ko Hawaii nei mau ipu kahiko mai elua ipu he ipu laau, he ipu pohue.

21. O ka poe akamai i ke kalai ipu kalai no lakou i ipu ma kekahi laau, aka, o ke kou ka laau kalai nuiia i ipu, e kalaiia na pauku laau mawaho, a hooliloia i umeke kekahi, a i ipukai, a e pao maloko a hohonu a e hana palanai kekahi i ka laau maluna o ka ipukai, a pau ia hana ana.

22. Alaila, e anai i ka puna maloko a mawaho, a pau ia, alaila anai hou i ke oahi, a pau ia anai i ka ana, a pau ia, anai i ka oio, a pau ia, anai i ka nanahu, a pau ia, o ka lauohe, a pau ia, lohi aku ka lauhuhu me ke kapa, o ka ipu iho la noia, e hana i poi a i koko, ma ka umeke ka ai, ma ka ipukai ka ia.

23. O ke pohue, he ipu ia i kanuia a hua mai, nana no i hua mai ma ke ano umeke, a me ke ano ipukai, a me ke ano huewai, he awaawa maloko oia ipu, he awaawa ole kekahi ipu, e wau ka pala maloko a pau, a kaulai maloo, anai a pau o loko o ka ipu, iho la noia, e hana i poi, i koko mawaho o ka ipu.

24. E hoopala ka hue, a hahao i iliili maloko, a lulu a pau ka pala, a ku i ka wai a manalo, oia ka huewai.

25. O ka paakai kekahi mea e pono ai he mea e ono ai ka ia a me ke koekoe o ka paina ana, he mea hanaia ke paakai ma kekahi aina, aole i hanaia ma kekahi aina o ke kai ma kai e kii aku no ka wahine, a lawe mai ma ke poi, a he kai hooholo ia mai kekahi ma kauwahi mai.

26. E waiho kela kai ma kekahi poho paha, he ekaha paha, he kaheka paha, alia malaila lawe ho ma kauwahi e, o ka paakai iho la noia, o ka papalaau ka mea kui poi.

27. O ka wai kekahi mea e pono ai he mea kii wale aku ka wai ma kahawai, he mea eliia

20. The calabash was a good thing in which to put food and fish in the old Hawaiian house, and these were of two kinds, the wooden and those formed from a gourd.

21. Those who were skilled in carving bowls carved them from this and that wood, but kou was most commonly used; it was cut in blocks and first shaped outside, an umeke this, an ipukai that; it was dug out deep within for the former, shallow for the latter; a cover was made for the ipukai and the work was done.

22. Then with coral was the inside and the outside rubbed smooth; this done the rubbing was repeated with polishing stone and pumice; then was used charcoal and bambu leaf, and finally banana leaf and kapa. After this the bowl is provided with a koko. The umeke is for poi, the ipukai for meat.

23. The ipu was the fruit of a vine that was cultivated, and the fruit was worked in the shape of an umeke, an ipukai or a huewai. Bitter within were such gourds, others were not bitter. The soft inside was scraped out and the shell dried; when dry it was rubbed inside, a cover made and a koko.

24. The water-gourd was rotted, then small stones were put in and shaken until the soft mass was removed, then water was left in it until it was tasteless, and the huewai was done.

25. Salt was an article proper for the house; it was used for preserving fish, in cooking food, and at meals. Salt was made not here and there but in certain places where the women brought sea-water in the covers of calabashes or led it in ditches to shallow ponds.

26. Such water was left in holes perhaps, in shallow ponds perhaps, until it became strong brine, then it was taken to crystallizing pans where it became salt and was pounded on a board like poi.

27. Water was a necessary thing that was brought from springs or streams, or dug for in

kekahi wai. O ka wai kekahi mea e pono ai ka paina ana, no na puna, a me ka wela o ka paina ana.

28. O ka ai, o ka ia, o ka paakai, a me ka wai, o keia mau mea ka mea e pono ai ko loko o ke kanaka.

29. O ka niho mano ko Hawaii nei mea e ako ai e ka lauoho. Ua kapaia he niho ako lauoho. E hoa ka niho mano ma ka laau a paa, a pepelu mai a ka lauoho maluna o ka niho mano, a malalo o ka niho mano, alaila, o aku imua me heunuunu la ke ano, a i eha loa e puhipuhi i ke ahi, oia ka lua o ka mea ako lauoho.

30. O ka Hawaii nei aniani kahiko, he papalaau, e anai a maikai, alaila, paele i ka hili, a paele hou i ka lepo, a eleele a hou i ka wai, alaila, nana aku, he wahi ike pohihi no, he pohaku kekahi aniani, e anai a hou i ka wai, alaila, nana aku.

31. O ka launiu ko Hawaii nei peahi kahiko, e ulana a palahalaha o ka loulu kekahi peahi, he peahi maikai ia, e hanaia ke kumu i ka aha. O keia mau mea no na mea i pono ai ko ka poe kahiko noho ana ma Hawaii nei. (Aloha ina lakou!)

the ground. This water was a good thing at meals to prevent choking and to cool hot food.

28. Vegetables and meat, salt, and fresh water, all these things are necessary for the inner man.

29. A shark's tooth was used in Hawaii for hair-cutting. It was called *niho-ako-lauoho*. The shark's tooth was fastened to a wooden handle; the hair was doubled over the shark's tooth, then this was pushed quickly forward while the person shrank back with the pain; some burned it off with fire; such was the second way of hair-cutting.

30. The ancient looking-glass of Hawaii nei was of wood well polished, then dyed black with bark, again dyed with mud and blackened with water, then gazing at it a faint image appears. Stone carefully polished was dipped in water and then reflected the image.

31. The coconut leaf was the ancient fan of Hawaii; it was braided flat; the loulu was also used; a good fan was that, and the handle was wound with coconut cord. Such were the possessions of the old-time people who dwelt in Hawaii nei. Great pity for them!

With the native account as a text we may wander away to a consideration of what these "belongings" really were, and we may either take the most primitive to begin with and in our imagination build up little by little the necessary utensils of a poor man's home, or we can collect all the things we know the Hawaiian used, stock his house generously, and leave each reader to subtract what seems luxury from the bare necessities of life with a primitive man, or for the matter of that with a modern poor man. I have chosen the latter procedure, and although I shall try to describe all that a well-to-do man, a chief, one of the *alii* had in his home before the second advent of the white man at the time of Captain Cook's visit, I will also indicate in some measure what I believe the order of acquisition. Let us limit ourselves to the belongings of household life, reserving the worship, the food and amusements for other chapters.

One thing will be very apparent, there was very little for exhibition or ornament; everywhere utility reigned. There was no endeavor to harmonize the carpets with the wall coverings, or the furniture with both. And yet that very thing was done unconsciously, for the mats that covered the stone, earthen or gravel floor matched perfectly with the grass or hala leaf lining of the walls, and the dark gray of the stone implements and the orange of the gourd containers with the deeper colors of the umeke struck no discordant note. It is useless to say that if it had no eye would have been offended in the dimly lighted interior; almost all the furniture was used out of doors and only stored within; but whether placed by the brookside under the trees, in the lanai, or piled up on the gray stone platform around, or at least in front of the house, there was not a shining tin pan or kettle, nor a vilely decorated bit of crockery (as so often in modern degenerate times) to offend good taste; everything harmonized as commonly with the uncorrupted children of the simple life.

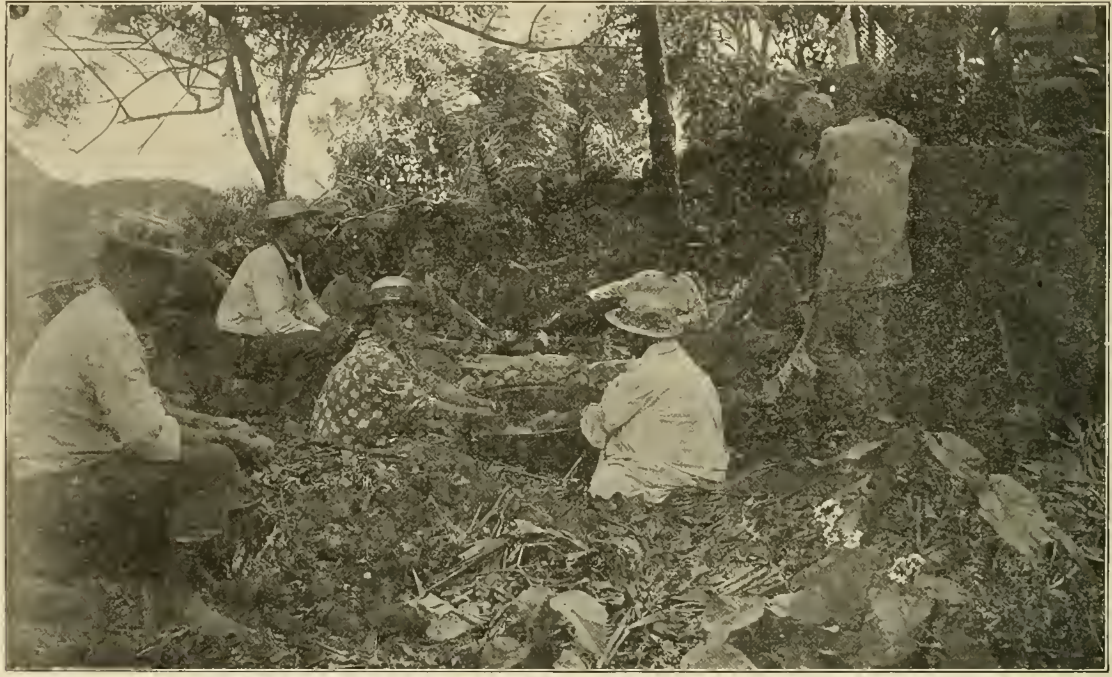


FIG. 100. POI MAKING OUT OF DOORS. A SCENE AT HALAWA, MOLOKAI, IN 1888.

The universal out-of-door life in the fine climate of Hawaii kept the house clean and permitted the use of a floor covering of mats of fine texture; much better these than the rushes strewn upon the floors of our Anglo-Saxon ancestors. These mats have already been described in the publications of this Museum,[63] and it need only be repeated here that in the better houses the actual floor was covered with several layers of mats, sometimes all of pandanus leaf but in fineness increasing from the bottom layer, at other times the lower ones were of pandanus and the upper one of *makaloa*, a fine rush of which the best and most durable Hawaiian mats were made. On the general coarser mat covering of the floor was often placed the bed or *hikiee*, a structure of mats interleaved with extra strips of matting at the front edge, and often extending the length of the one room of the sleeping house. Sometimes this hikiee was placed on a slightly raised platform or kahua like an oriental divan, but I believe this a comparatively modern innovation. I have never seen such a kahua in the ruins of the old houses that are dotted over the group. All the family and guests slept together on this long bed which often was more capacious than the famous bed of Ware, and not infrequently the pet pig of the family joined the company of sleepers.

---

[63] Hawaiian Mat and Basket Weaving. Memoirs ii, pt. 1, 1906.

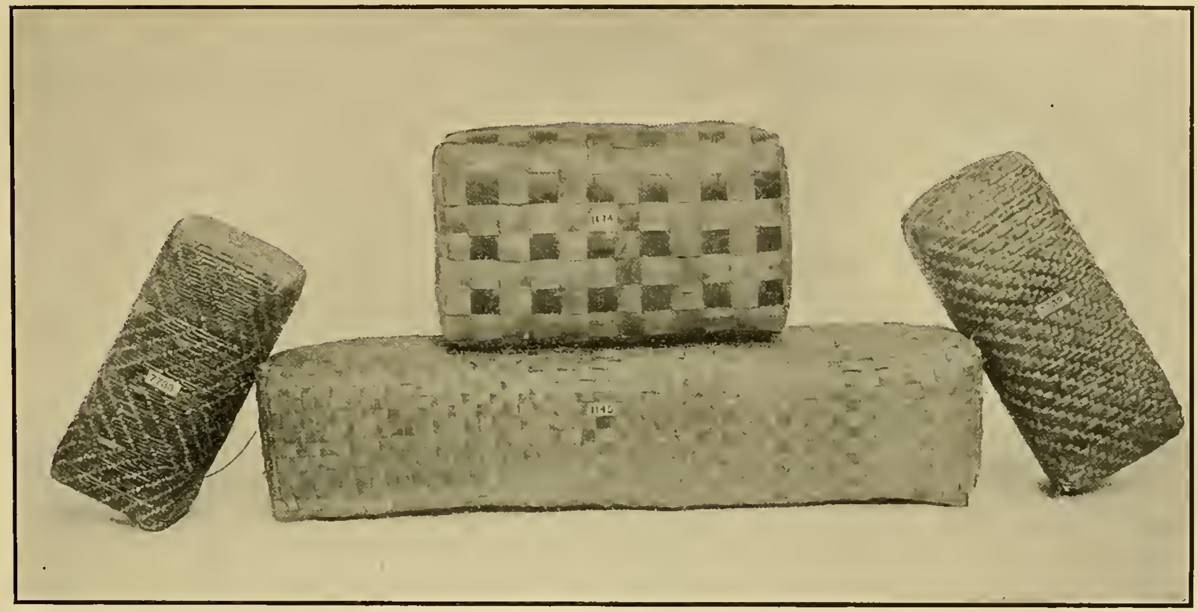


FIG. 101. ULUNA OR PILLOWS.

Uluna or Pillows they had, as shown in Fig. 101, woven of smooth pandanus leaves, and stuffed with other leaves, most comfortable even for an European. As the illustration shows these pillows were sometimes of ornamental weaving, but they commonly were plain and of various sizes to suit the owner or user. In the earlier houses the expedient sometimes seen in poorer houses of later times of a log or bolster, extending the length of the hikiee was no doubt common. They had also a wooden pillow, as Malo says, but I do not know of an example extant, nor have I ever seen one in use in a native house. A stone pillow was found some time ago at Kilauea, Kauai, a locality noted for its good stone work, and this may have resembled the wooden one. The stone one is shown in Fig. 102. It is cool and not so uncomfortable as might be inferred from its material[64] The body is flat on the outside and convex on the body side; the legs are slightly notched to prevent slipping on the smooth surface of a mat bed. I know of no other specimen of the stone pillow; only the frail mat pillows have survived to the present time.

---

[64] This uluna pohaku was kindly loaned me for examination and to photograph by the owner, Mr. J. R. Myers, of Kilauea Plantation.

Kapa Moe.—They also had bed clothes (*kapa moe*) of the paper made by felting the fibres of the paper mulberry into large sheets, five of which usually formed a *kuina* and were stitched together with a tape of kapa at one edge leaving the others free. The sheets were of an average size of six by eight feet, but there is one in this Museum ten and a half feet by twelve, and others nearly as large. Four of the kuina or set of sheets were generally white or yellow, while the outside sheet (*kilohana*) was colored or decorated with imprinted figures or lines. Such a kuina was quite warm, and I have found them unbearable over my ordinary clothes when sleeping on the summit of Mauna Loa (13,675 ft.) when water was freezing at my feet. The Hawaiians of the olden time were clothed only in the *malo*, a strip of kapa or matting perhaps nine inches wide and two yards long; this with the women became a *pa'u* which was about a yard wide and of considerable length; neither sex wore night clothes. Both sexes, however, used in cold weather a shawl of kapa called *kihei*. Some authors have stated that the Hawaiians wrapped themselves in the kapa moe in sleeping, and I have seen them go to the door of their house on a chilly night in the mountain region wrapped in it as a white man might use a blanket, but while it is quite probable that they had individual peculiarities in the matter, those I have consulted have generally slept with the *kapa moe* over them in the usual manner of bed coverings. Precisely in this way those who slept the last sleep were covered by a sheet of black kapa, and one recalls the message sent by the last king of Kauai to the conquering Kamehameha,

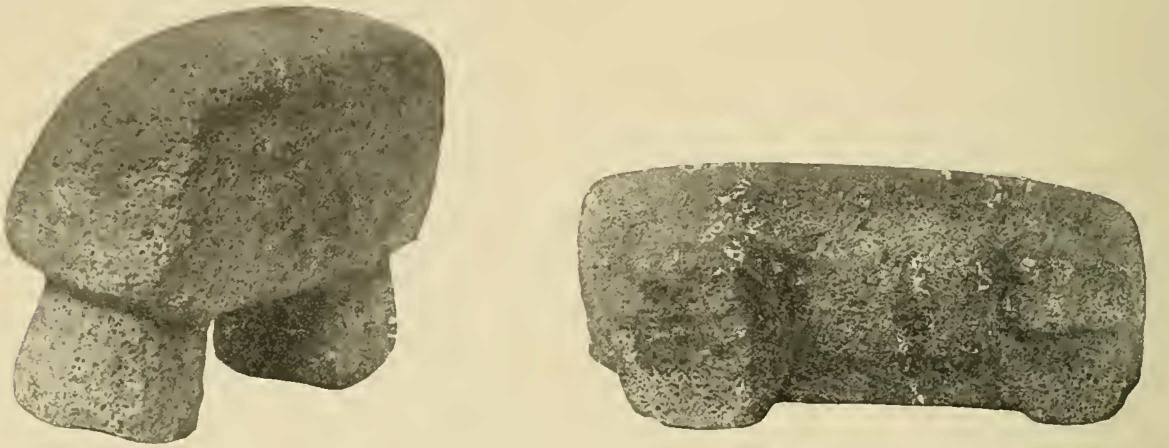


FIG. 102. STONE PILLOW FROM KILAUEA, KAUAI.

"Wait until the black kapa covers me and my kingdom shall be yours." I cannot here follow up the manufacture of kapa, which will require a chapter by itself,[65] but the chief implements used in this most important work were a part of the furniture of every important house, and must be briefly described and illustrated here.

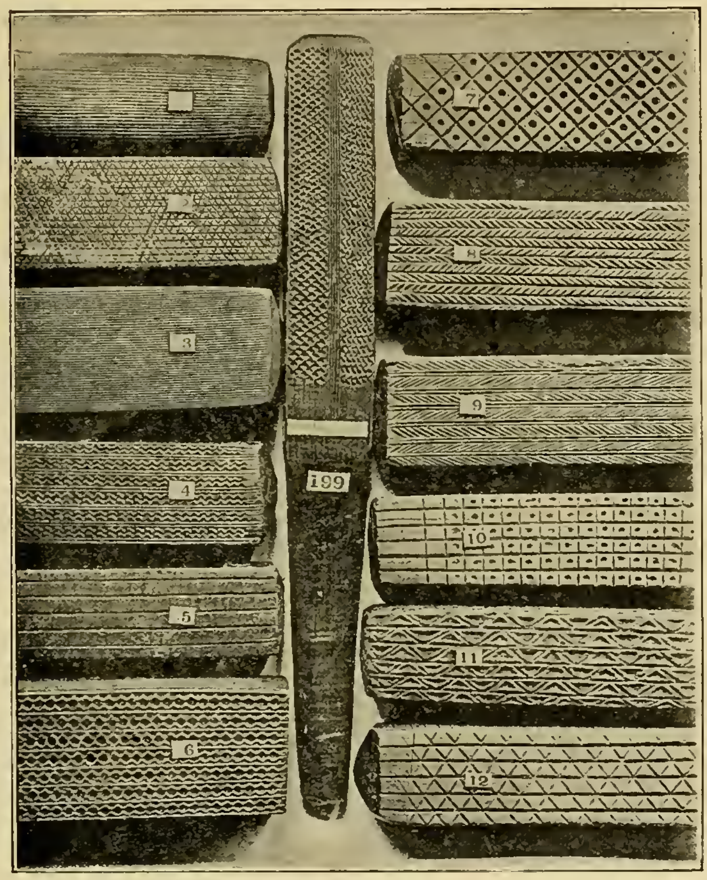


FIG. 103. KAPA BEATERS.

No loom nor complicated machinery was needed for the simple process by which the fibres of bark were converted into sheets of varying size and consistency. A log of some hard wood, usually of *kawau* or *kolea* wood, was cut to a length of about six feet, hewn to a flat surface about three inches wide at top, cut away slightly at either end and hollowed out longitudinally underneath. This anvil, *laau kui kapa* or *kua kapa*, was supported on two stones. Fig. 104. A variety of hand clubs, some round (*hohoa*) for the first beating, or square (*ie kuku*, Fig. 103) for the finishing, and a few calabashes to hold water or some mucilaginous liquid, were all the tools needed to make what was probably called from the means used in its fabrication Kapa = *ka pa*, the beaten.

In olden time the kapa beating was done in one of the six houses (hale kua) of a well-to-do Hawaiian, but in later times I have usually seen the old women establish their *kua kuku* under some tree near a brook or kalo patch. The patterns on the beaters were various and these determined the "water mark" on the kapa: the form of the beater and some of the patterns are shown in Fig. 103. These beaters are perhaps the most common Hawaiian article in museums, and they must have been very abundant, as after their original use had become obsolete, scores were used up in trying to reduce to fibre the foreigner's clothing in their primitive process of washing by beating the wet fabrics on a flat stone.

---

[65] I more willingly pass over the very important work of kapa making without a complete description because a rather lengthy memoir devoted to that manufacture, in which the Hawaiians excelled, is in preparation and will be fully illustrated with photographs and colored plates.

As there were no mosquitoes on the Hawaiian Islands before 1827, the old natives had no need of mosquito nettings so indispensible in the southern islands of the Pacific, and the *tainamu* of the Samoan was not known on Hawaii in the "good old times". Sleep was often broken to go to the *poi umeke*[66] and satisfy their frequent hunger. In the day time the kapa moe were carefully folded and put aside as were the mat beds of the Samoans. The author can bear witness to the great comfort and restfulness of this old Hawaiian mat bed and pillow in a new and clean house, and it is no wonder that modern Hawaiians who have frame houses after the foreign style and bedsteads and other foreign furniture, still prefer to sleep on their mat bed *under* the cumbersome foreign bedstead. Once the author, in passing the night in such a house in a fine four-poster with mosquito nettings, was awakened at daybreak by a slight noise and saw his host and hostess crawling carefully out from beneath the bedstead, where they had comfortably passed the night.

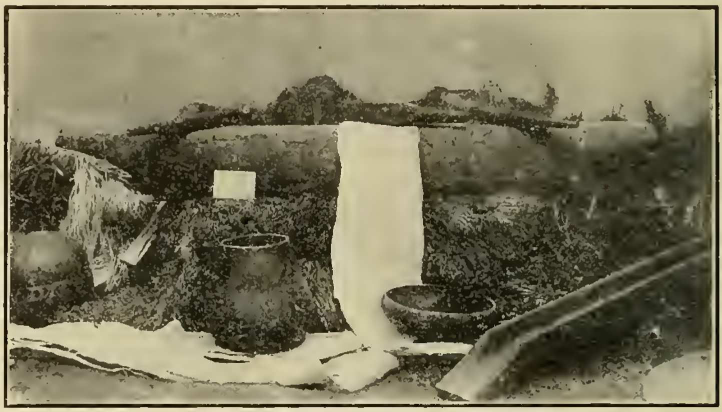


FIG. 104. LAAU KUI KAPA.

When foreign customs began to be observed, partitions were made temporarily in the one room of a native house by sheets of kapa hung on cords. When traveling here in the early sixties with ladies this convenience was generally offered by our obliging hosts; often this was the sole exception to the antique *modus vivendi*, and yet it made the little one-roomed house seem very foreign to have this fence rather than partition stretched from wall to wall. It destroyed the extreme sociability of the old Hawaiian way.

Before we turn from the subject of bed and its use, we may describe a custom rather than the apparatus, that to old residents seems almost a part of the native house; and yet today the articles I am about to describe (Fig. 105) are hard to find, and not many have been preserved in museums. If Morpheus or his Hawaiian equivalent refused to be propitious, and sleep was coy, the old natives had a soporific always sure and never harmful.

---

[66] Poi umeke = the bread basket. Poi was the paste made from the cooked root of the kalo, and was the staff of life to the Hawaiian. Its manufacture and modifications will be described in the chapter on the food and cookery of the Hawaiians.

Laau Lomilomi Kua. Back Rubbers. — Obesity being a much coveted condition among certain chiefs of either sex, although perhaps more among the females, eating in excess of the requirements of a natural appetite was resorted to and in consequence some passive exercise was needful to digestion, and the delightful process of *lomilomi* or massage was applied to the fat masses of poi, fish and dog. But not merely by gluttons, but by the muscle-weary was this process indulged in. Constipation, headache and many other ills yielded to the skilful manipulation of the old women who were reputed the best operators.

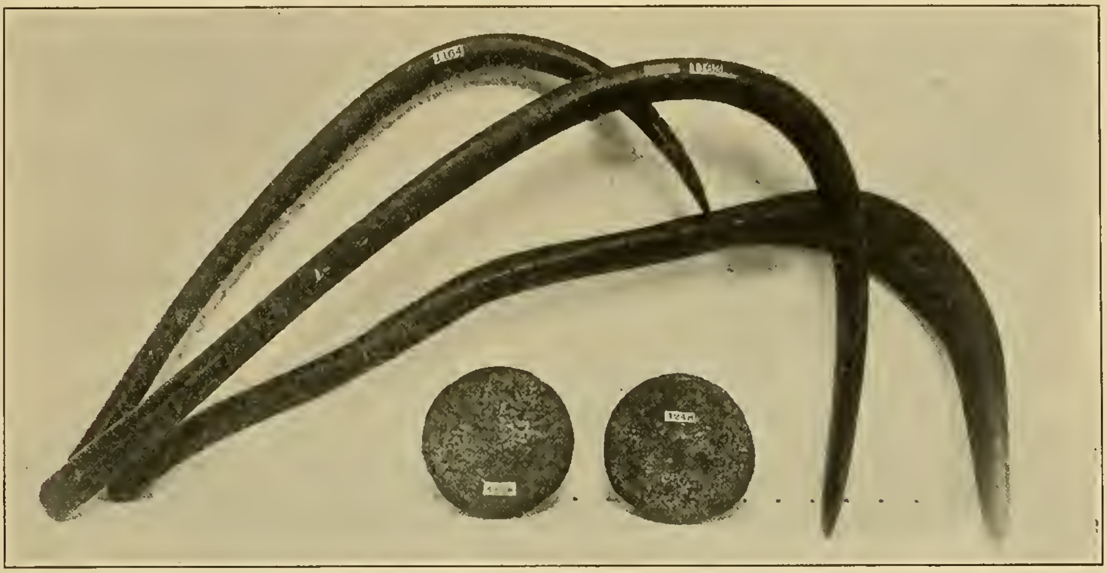


FIG. 105. LAAU LOMILOMI AND BATH RUBBERS.

I am not copying what is usually said of a Hawaiian lomilomi; I know of it intimately by repeated personal trials. Once I had been in the saddle all day on a slow horse traveling the then execrable trail from Hilo to the volcano of Kilauea in a rainy season. Arrived late at night at the grass house that then served to shelter visitors at the brink of the crater, I dismounted so stiff and weary that I could not sleep, I could hardly sit down. Fortunately there were then many natives living in that desolate neighborhood employed in the long since abandoned work of *pulu* gathering (pulu being the silky down at the base of the frond of the tree fern of the neighboring forest, the product being then in demand for stuffing pillows and beds), and among them were found two old women noted for their skill. I removed all unnecessary clothing, dropped on the mat, and the lomilomi began. At first they gently kneaded the muscle from the extremity to the trunk, then tapping in succession with finger tips, knuckles and closed fists, and ending with a minuet danced on my abdomen, and a march on their heels up and down my spine. I think they, in the course of this, ran their heels down every rib as if it were the key of a piano. They also "cracked" each finger joint and even my neck; at first it was ticklish; then dreamy; then restful, and after an hour of this I got up so refreshed that I could have ridden all night. Instead I at once fell asleep.

Foreigners have learned the process to some extent, but the old native *poe lomilomi* are extinct.[67] On the whole I consider the old Hawaiian lomilomi far pleasanter than the massage that one gets from the most approved operators in the best baths in Cairo. At times one might wish to exercise his back, and without assistance at hand, the laau lomilomi shown in Fig. 105 were most useful, and were found in every house in the olden time. In a grass house where there are no door posts, they were certainly a great addition to the comfort of the *human* inhabitant. In the Bishop Museum these sticks are placed in the medical alcove, where they belong, but they always seem a necessary part of the furnishing of a hale pili. The round stone rubbers shown in the same illustration, were of cellular lava, and in the ablutions took the place of the then unknown soap. It was sometimes well to use them after a lomilomi.

The specimens of laau lomilomi kua in this Museum are as follows:

1163	Of kou wood, large.
1164	
1165	
1166	Of kauila wood; from Kalihi, Oahu.
1167	From Honaunau, Hawaii.
1168	Of nenelaau wood, Kailua, Hawaii.
1169	Kona, Hawaii.
1170	Kona, Hawaii.
1171	Kona, Hawaii.
1172	Kona, Hawaii.
1173	Kona, Hawaii.
1174	Of ulei wood; N. Kona, Hawaii.
1175	Of nenelaau wood; Kailua, Hawaii.
1176	
1177	

If my native house had at this time human inhabitants, my reader might justly say that I had put them to bed not only without their supper, but without a light! While the chapter on Food might be appealed to for the supper, it would be unfair to leave out the light for while the old Hawaiians often went to bed with the chickens, they did not like the dark more than other Polynesians, indeed than children of any race. In the cooler parts of the country the fireplace was fed with slow-burning fuel for a dim glow, for which the *mamane* (*Sophora chrysophylla*), a tree common on the uplands, was most fit. Torches (*lamaku*) were made by stringing the meats of roasted kukuinuts (*Aleurites moluccana*) on the midrib of a coconut leaflet and binding a number of these strings with dry banana leaves into a cylinder some six inches in diameter, and from two to four feet long. This lamaku produced a bright light, convenient for a night-time dance or revel, but it gave out too much smoke to be tolerated in the ill-ventilated houses, although the glow was pleasant through the open door. The usual evening light for the interior was the stone lamp fed with kukui oil and supplied with one or more wicks of twisted strip of kapa, or with the older and simpler candle of these same nuts first roasted and shelled and then strung as in the torch but in shorter lengths. Such candles it was the duty of the younger members of the family to care for, and they were "snuffed" by inverting the candle until the next nut was alight and then knocking off the embers of the spent nut. The odor was strong, resembling that of roasting peanuts, and care had to be taken that the half extinguished coal did not set the mat carpet afire. As shown in Fig. 106 the same stone lamp that held the oil could also be used for candlestick for the nut candles.

---

[67] On camping excursions I have often applied this massage to the relief of my companions, and Judge Sanford B. Dole, president of the trustees of this Museum, is very skilful in this Hawaiian art.

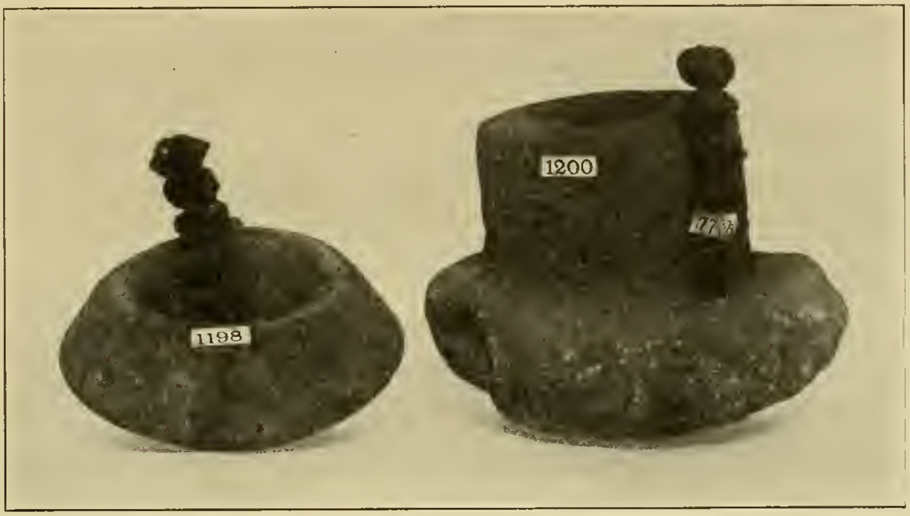


FIG. 106. KUKUINUT CANDLES.

The lamps were of many forms, not very portable but durable beyond most modern lamps. Their forms are shown in Fig. 107 and others are described in the already published account of Hawaiian Stone Implements.[68] The oil was ground out of the nuts in stone mortars many of which are figured in the same work (p. 366), and all important houses had one or more of these, as the oil was home-made. Fig. 108 shows a common form of mortar, but some were of considerable size and good workmanship. Usually the stone pestles were neither so large nor so neatly finished as those of the Amerind, but then the latter had greater use for the implement in grinding meal for his bread. Although the nut season was a long one there were times when the supply must have failed these improvident children of nature, and the fat of a pig or a dog served as substitute.

---

[68] Memoirs of B. B. Bishop Museum, vol. i, pt. 4, p. 391.

Doubtless a chief had many adzes, slingstones, clubs, sinkers and many other stone implements about his house, but these have been described in the work referred to, and we can only here call particular attention to the poi pounders which from their continued use seem to connect us with the stone age, as they were among the earliest tools fashioned by the Hawaiian immigrant on his arrival in these islands. His nearest patterns were in Central and South America. Their various forms are shown in Fig. 109 here repeated from the account of the stone implements as it shows the difference between pestles and pounders: the latter had no stone mortar to grind against, but were used on a flat and shallow wooden trough, which, when not in use generally leaned against the outer wall of the house and was plainly visible from a distance.

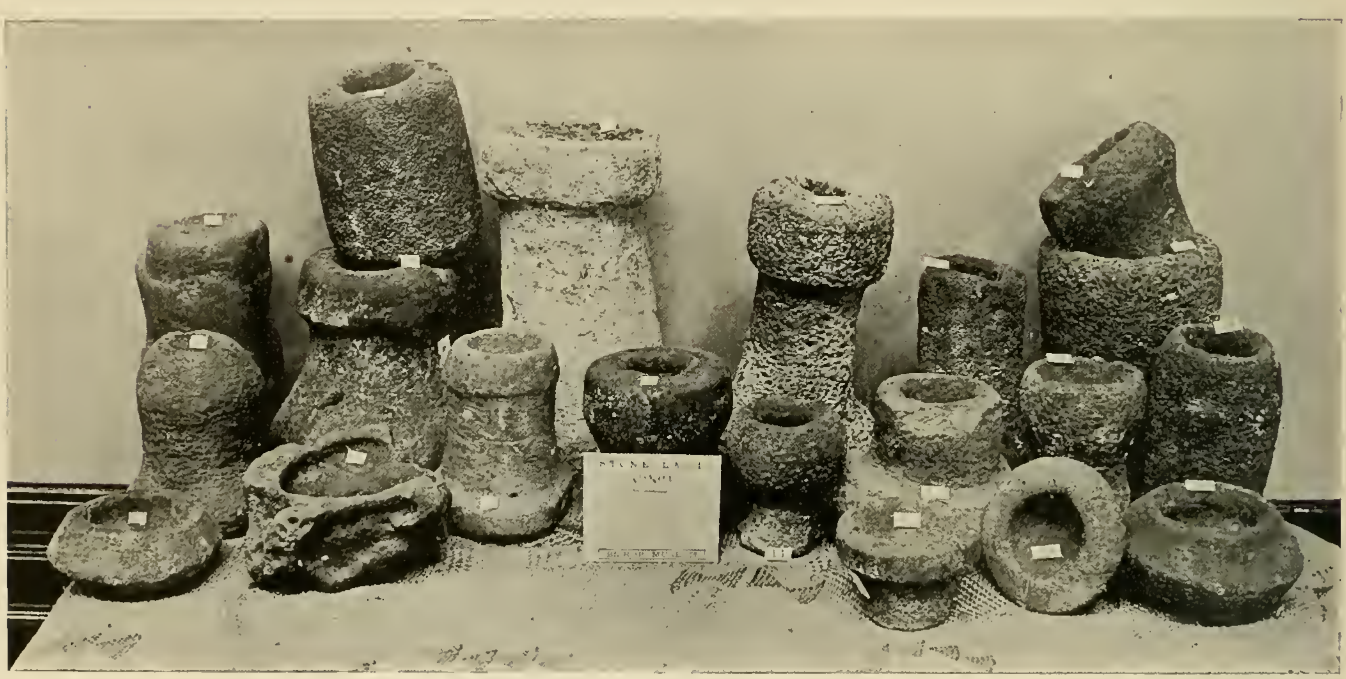


FIG. 107. STONE LAMPS.

These poi troughs (*papa kui poi*) were hewn from some tough wood, as ohia (*Metrosideros polymorpha*),[69] and are either of small size for convenience in traveling, when the alii always, if possible, had their attendants carry all the requirements for making poi, or if for home use of sufficient size to serve two persons pounding, one at either end and each with his own portion of kalo. A very old poi board in the Bishop

---

[69] In modern times the natives and Chinese make much use of the softer wood of the Monkey-pod (*Pithecolobium siamang*).

Museum, Fig. 110, is of an irregular circular form, thirty-nine inches in the greatest diameter, while in the same collection another which can boast of less antiquity, but of the most approved form is sixty-five inches long and twenty-three and a half inches wide. As the stone pounder struck the elastic mass of poi and not the trough, this lasted through several generations of poi makers. At present most of the poi consumed in Honolulu is made by the industrious Chinese or at the poi factory where modern machinery and methods are used in Kalihi.

Although in the enumeration of the houses of an Hawaiian alii's establishment no mention was made of carriage house or barn, yet they all kept a carriage, though of the most primitive form. In war the *pololu*, a long stick of kauila wood, formed the carriage of the commissary department and went to battle, the ends resting on the shoulders of two men while the length was hung with neat bundles of hard poi (*paiai*) wrapped in ki leaves. If the chief fell in battle his retainers endeavored to save his body and carry it home slung by the wrists and ankles to this pololu. If he returned triumphant the pololu, which was often more than five yards long, was set up in front of his house as in later days a flag staff would be planted. That these carriages were held in respect let me quote the record attached to one in the Bishop Museum (No. 804): "The tree grew at Puukapele, Kauai, from which this spear was made for Kamehameha I, who gave it to his soldier and aikane Hema just before the battle of Mukuohai fought against Kiwalaó. Hema also used it in six other important battles, viz., at Laupahoehoe against Keoua Kuahuula; in a sea fight in the Moana o Alanuihaha against Kahekili and Kaeo; at the battle of Iao against Kahekili and Kaleikupule; in the battle of Kanaawa at Hilo, Hawaii, against Namakeha; at Keaau, Puna, in the excursion of Kaleleiki; at Kaunakakai, Molokai, againt Kaleikupule. In the peaceful times that followed the conquests of Kamehameha the old spear was trimmed into an *auamo aipuupuu* and used to carry the calabashes of the alii." Let us see what the less renowned auamo were like.

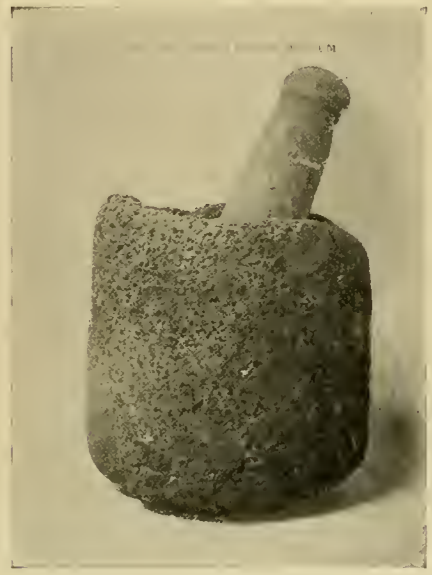


FIG. 108. STONE MORTAR.

Auamo.—To carry the gourds, umekes and other similar burdens poles were used, made of some tough wood, slightly bent and more or less notched at the ends. In Weber's picture of the newly discovered village at the mouth of the Waimea river

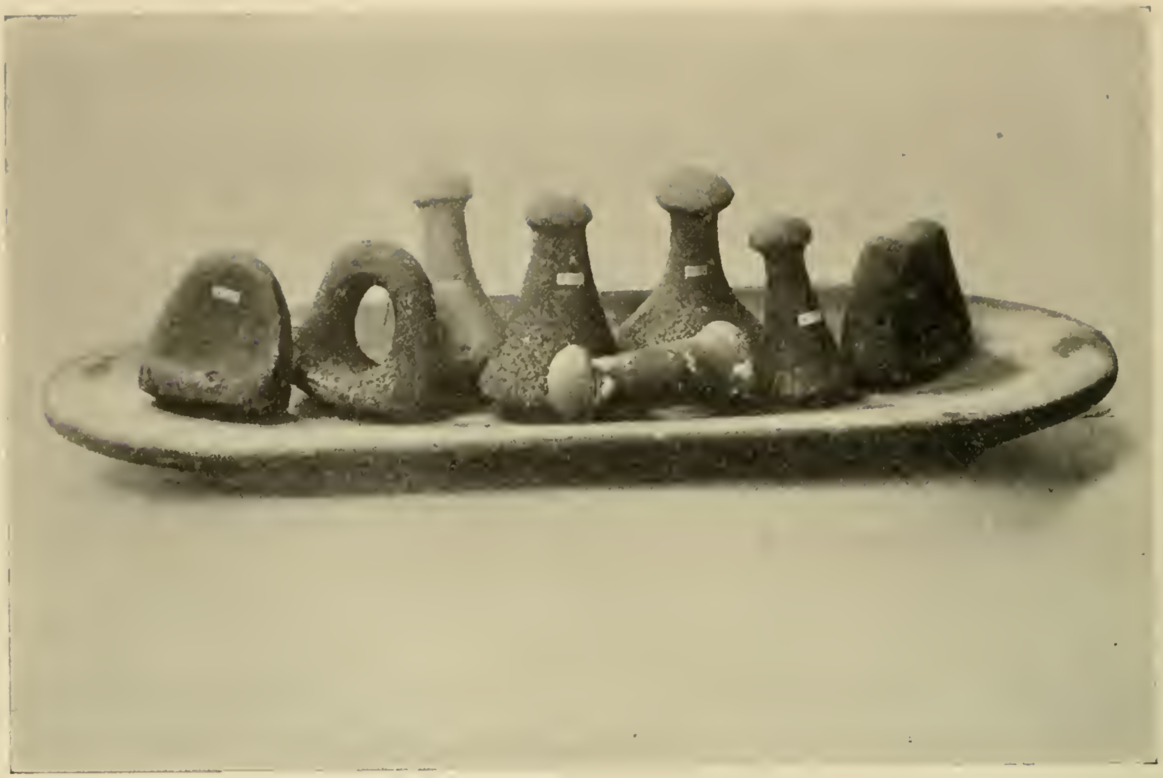


FIG. 109. POI BOARD AND POUNDERS.

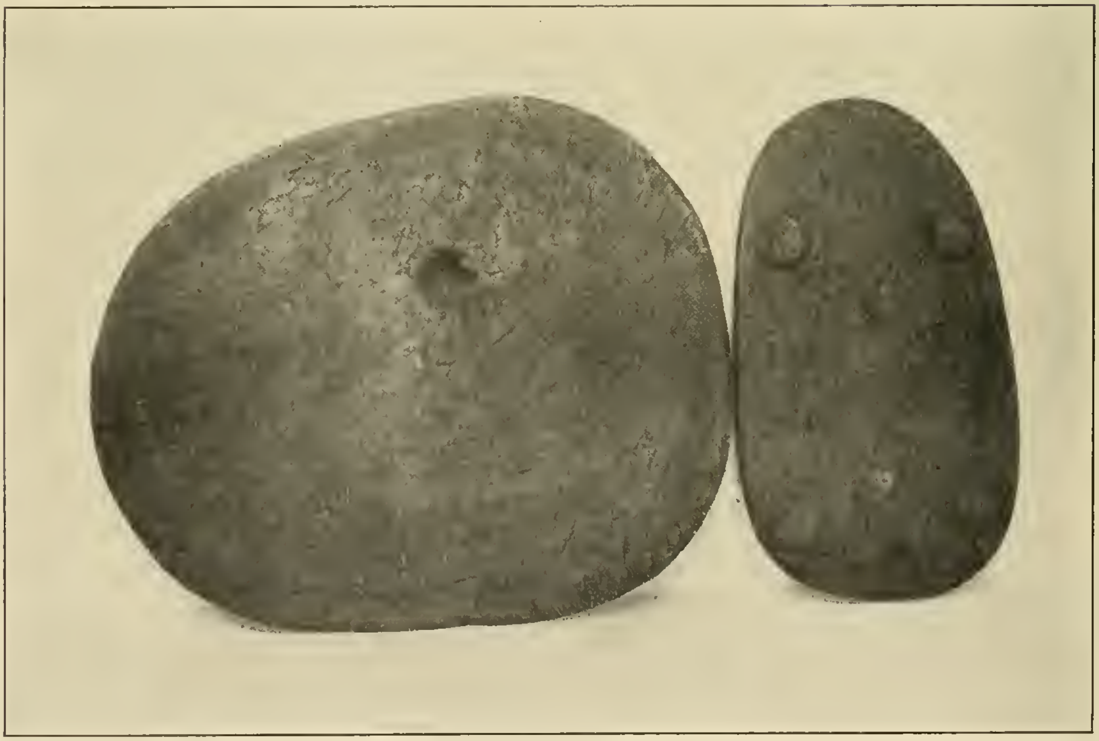


FIG. 110. POI BOARDS.

on Kauai, two natives are seen carrying a live pig slung on a straight pole resting on their shoulders, and in the old songs there are references to this bearing stick generations before Cook's visit. The section of an auamo was generally, if not always, circular, and not well fitted to rest easily on the bare shoulder; hence a porter was known by the callus formed at the point of contact.[70] These bearing sticks were also known as *aumaka* or *mamaka*. The Hawaiian sometimes used a straight round pole pointed at both ends for one especial purpose,—to meet the demands of foreigners for hay, an article not imported in the period previous to 1865. The native hay dealer skilfully packed two long bundles of grass in such a way as to seem of considerable bulk, but often containing but little grass. These he transfixed with his pointed pole and brought into market as shown in Fig. 112. Probably none of the present generation of Hawaiians ever saw these bundles, but I think I remember one native who brought me grass for my horse in Honolulu, using a genuine China stick.

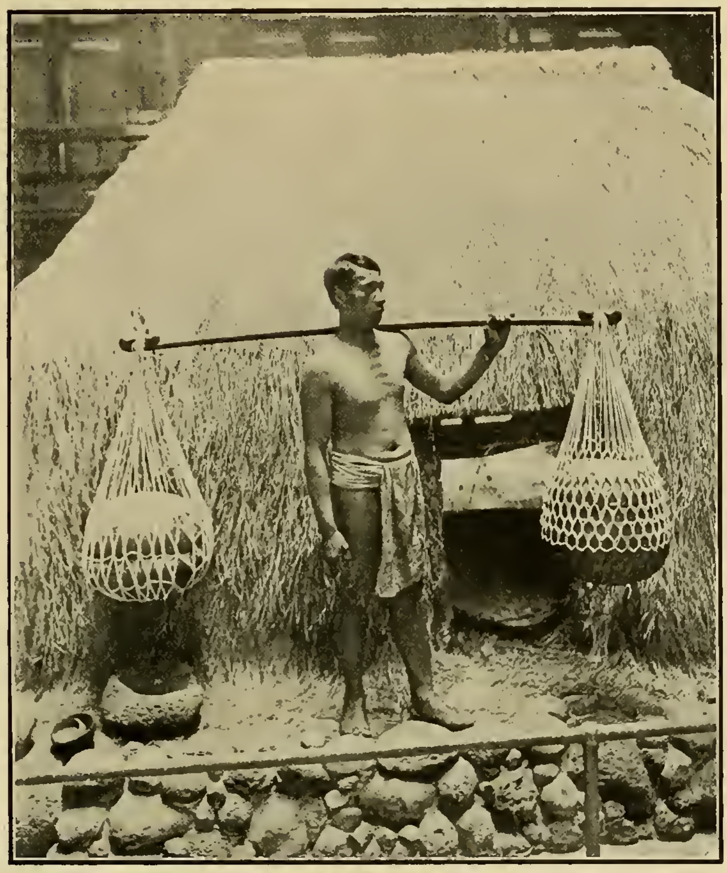


FIG. III. BEARING THE POI OF AN ALII.

Of course a well-to-do man or a chief did not use auamo, but he had to provide them for his servants, and the specimens existing in this Museum show that more care was expended upon these implements than would be expected of mere porters. Fig. 113 shows the ends of some of these auamo, and the following list gives their material and length:—

---

[70] The bearing stick of the Chinese is much better suited for the purpose having a broad, almost flat surface where it rests upon the shoulder and is without notches, although sometimes one or two pins were inserted to answer the same purpose as notches. It is easy enough to keep the suspended baskets from slipping off in the flat country of China, or of most Chinese towns, but the Hawaiian had to climb most difficult paths in his native islands, and it would often be impossible to keep the pole perfectly horizontal. The Chinese poles were early introduced (before Vancouver) but were not copied by the Hawaiian. A good "China stick" is six feet long; two inches wide at each end and at the middle, tapering between these points; is one and a quarter inches thick at the middle and weighs only three pounds.

LIST OF AUAMO IN THE BISHOP MUSEUM.

144 Auamo kii of kauila wood well carved with two human heads at each end. Made by Kipolo during the reign of Kamehameha III (d. 1854). 72.5 in. long; weighs 3.5 lbs. G in Fig. 113.

145 Auamo kii with two rudely carved human heads at each end. From Queen Emma's collection. 97.5 in. E.

146 Auamo kii with a head and three teeth at each end; the head perhaps of an akua. 69 in. D.

147 Auamo of ulei wood with three notches at each end. From S. Kona, Hawaii. 41 in. F.

148 Auamo of kauila; one notch. 45 in.

149 Auamo of koa, very old. 49 in.

150 Auamo of guava wood. Made by Kapela of Keauhou, S. Kona, Hawaii. 37.5 in. B.

151 Auamo of ulei with two notches at each end. 62 in.

152 Auamo of kauila wood. From Queen Emma's collection. 61.5 in.

153 Auamo of ulei. From Kau, Hawaii. 44.5 in.

154 Auamo. 43.5 in.

6695 Auamo of kauila wood. Ailau collection. 46.5 in.

7595 Auamo of kauila. 61.7 in. C.

9475 Auamo with projecting notch. 51 in.

9521 Auamo of akia (?) wood. 61 in.; weighs 4.5 lbs. A.

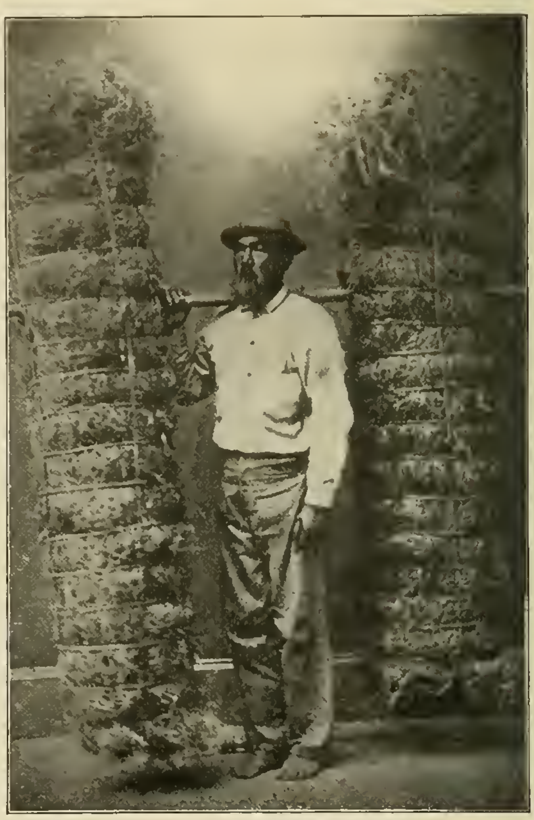


FIG. 112. HAWAIIAN HAY DEALER IN 1864.

9522 Auamo much bowed. 46.7 in.

9523 Auamo round and tapering. 46.5 in.

9524 Auamo of light wood, notch wide, raised. 49 in.

9525 Auamo of light wood, notch slightly raised. 49.5 in.

9526 Auamo of very light wood, one end mended. 44 in.

9527 Auamo of kauila, notch cut in. 54.5 in.

9528 Auamo, smooth and old, one end broken. 47 in.

9529 Auamo of kauila, slight notch. 46.5 in.

Gourds as Containers.—No Hawaiian laid up food for future use: he had not acquired the domestic economy of the Marquesan or the Kusaien who prepare food from the breadfruit or the pandanus during the seasons of plenty for the needs of other times. He had, however, to prepare his poi some time before a fermentation made it palatable, hence a number of containers were needed, and in most families there was a a never-failing supply of this national bread. Containers were needed, and the earliest, probably were the gourd shells, *ipu* of the natives, since this name has attached to vessels made for many generations of wood, as we shall see later, and even to the stone lamps (*ipu kukui*). The large gourd (*Cucurbita maxima*), *ipu nui* of the natives, was found on this group at the time of Cook's visit, although unknown to other Polynesians, and of unknown derivation. Its huge fruits are sometimes several feet in diameter, the rind thin and strong, and serve not only for bowls and dishes, but also for traveling trunks (Fig. 114), for which purpose they were well adapted by their toughness, lightness and impermeability to rain. Slung in the network *koko* from the auamo on the shoulder of a stout, active Hawaiian they have often accompanied the writer on mountain trails, one of the pair containing food, the other a change of raiment, while the bottle gourd in the middle carried water, often so hard to find good in mountain climbing on Hawaii.

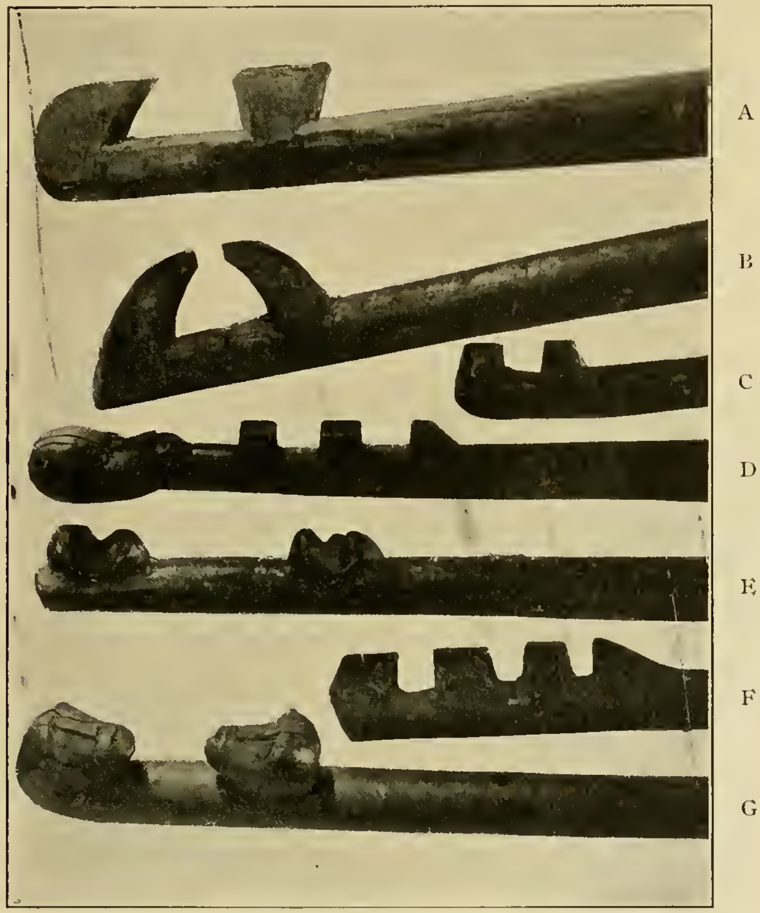


FIG. 113. ENDS OF HAWAIIAN AUAMO IN THE BISHOP MUSEUM.

As these gourds were on the islands or brought by the early immigrants, they were perhaps the first material at hand for containers, and they were certainly used widely and in many ways. They were always what took the place of crockery with

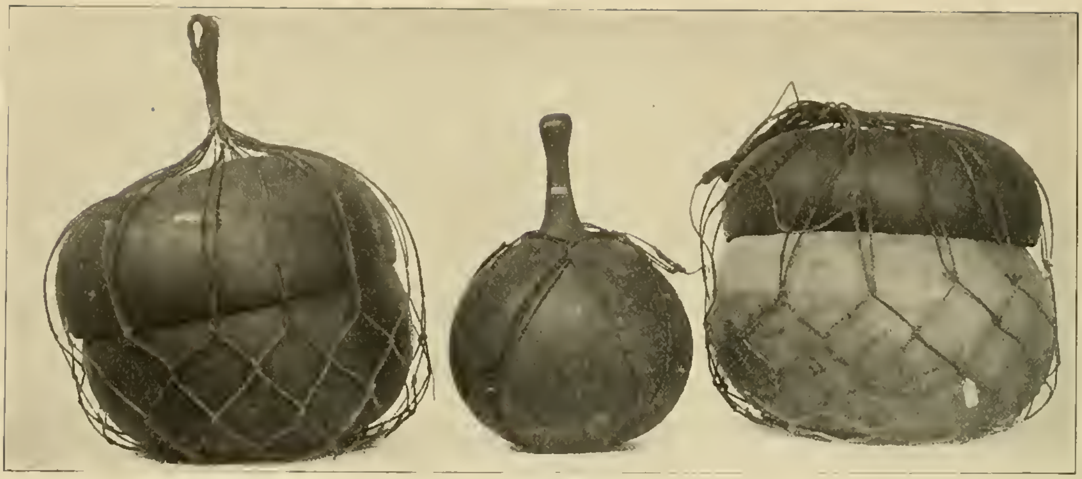


FIG. 114. GOURD CONTAINERS.

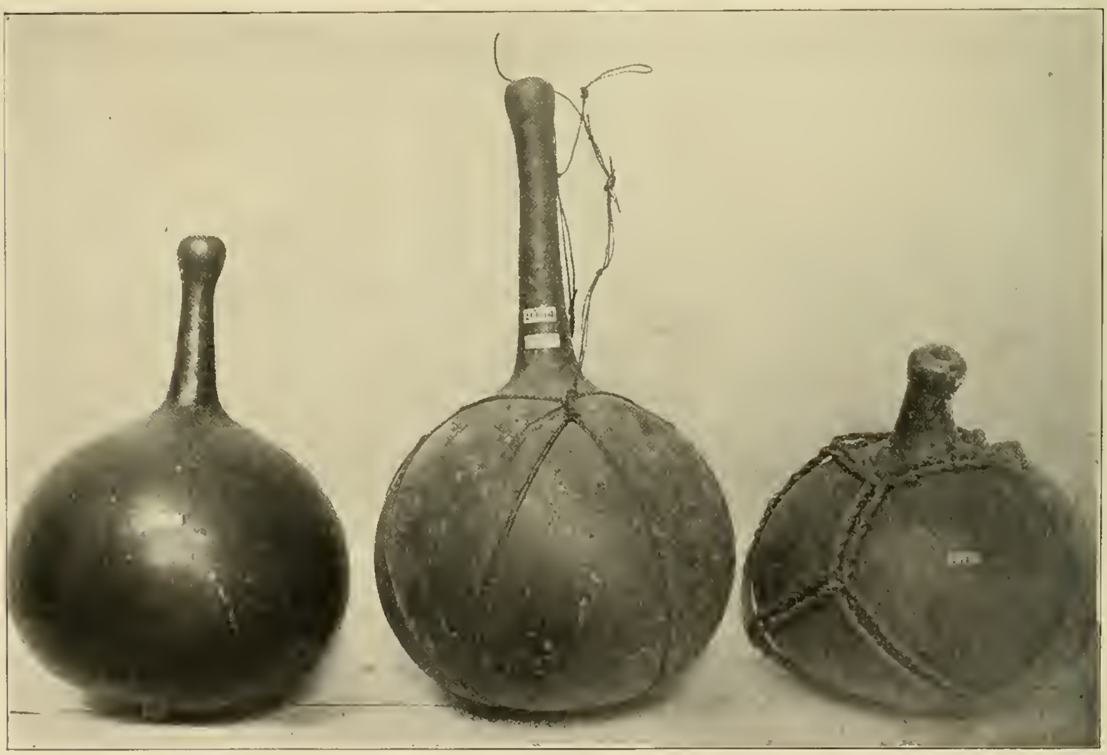


FIG. 115. BOTTLE-GOURD: HUEWAI.

the poorer folk, and with these they hold the same place today in the country regions. If the immigrants brought the seeds of this vegetable, as well as the coconut, with them their canoes must have had the capacity for freight that is fabulously imputed to the Mayflower. In the case of the gourd, while not emulating Jonah's, only a few months would be required to renew the supply, while the coconut, the only other source of containers, cups or bottles, would require twelve to fourteen years before fruiting: the latter vegetable pottery they used to an extent second only to the gourd.

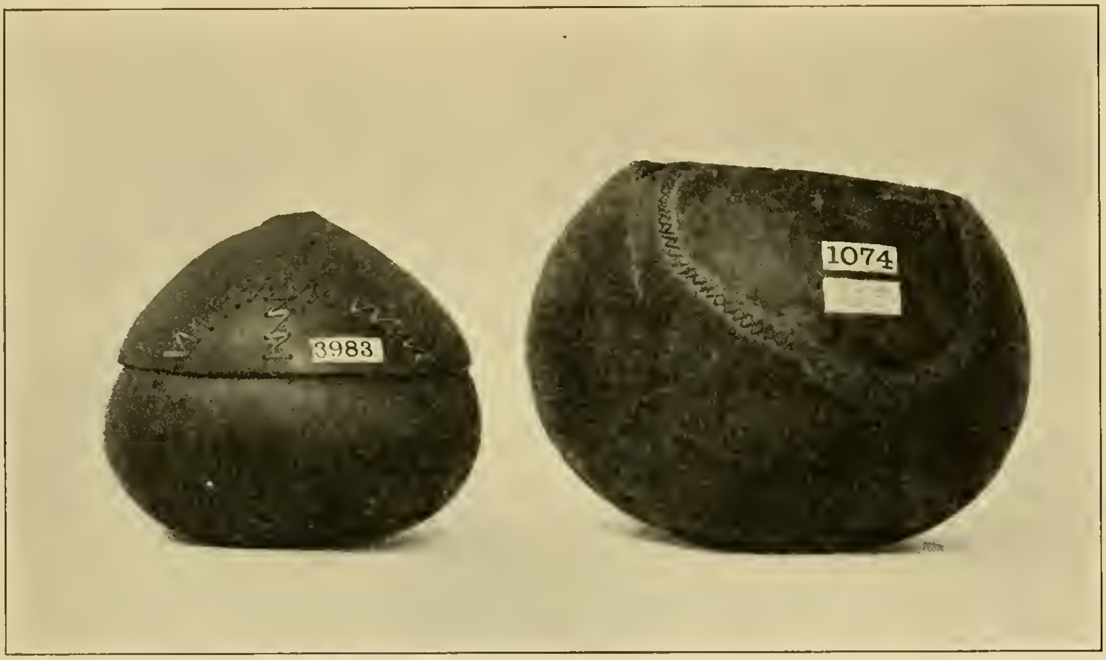


FIG. 116. MENDED IPU.

Besides the large Curcubita the Hawaiians had also the bottle-gourd (*Lagenaria vulgaris*), a vine found over a much wider territory than its larger relative, and with the two they were not meanly provided with vessels for containing food and drink. Easy to prepare, the ipu were fragile, and we find them neatly repaired with great pains, when broken, for the threads of oloná which were to bind the fragments together must be twisted on the thigh in the Polynesian way,[71] for they had no spindle, a refinement that the dwellers in the palafittes in the Swiss and Italian lakes had used sixty centuries before. Then holes for the thread must be drilled in the easily penetrated substance, and for this they had the pump drill which is found all over the Pacific islands, in Papuan as well as Polynesian groups. We have seen its use in the coarser work of door framing, and we have in Fig. 116 two specimens of neat work on the more delicate substance. Today in the time spent in mending these vessels of comparatively little value, one could earn enough to buy a dozen new ones. Not so in ancient days, for time was abundant and most of the ancient vessels both of gourd and of wood were more or less patched: as we go on we shall see many of these.

---

[71] See an illustration of this on p. 51, Vol. I, Memoirs of this Museum.

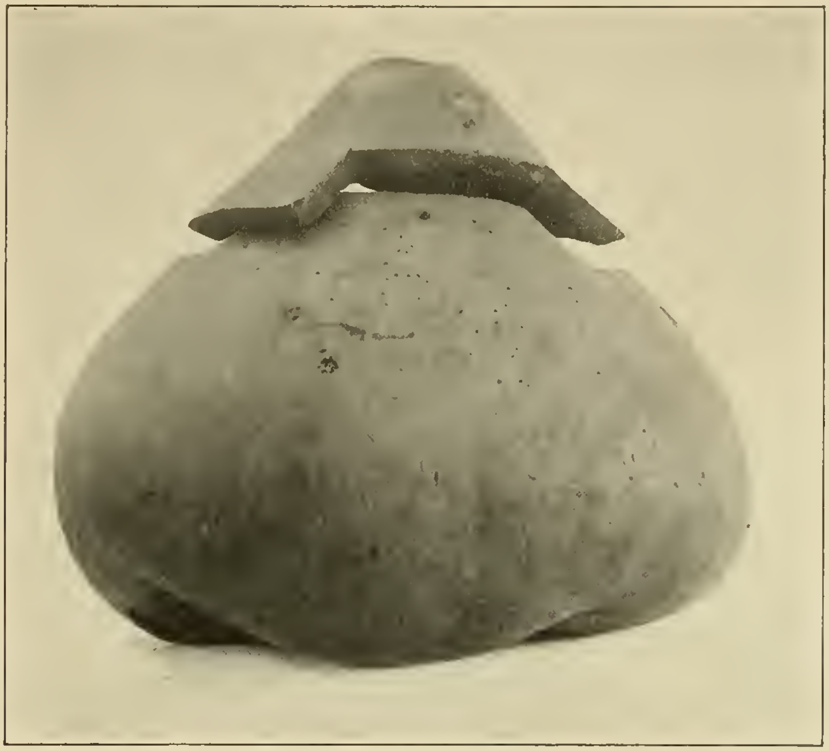


FIG. 117. GOURD BOX.

Of the Curcubita were made a great variety of things useful about a house as well as the large bowls. First were the covers for these bowls which also served as dishes when the bowls were uncovered, and the gourd covers were commonly used on the later bowls of wood. Long, narrow slices of these gourds made convenient platters, and fragments of broken ones were used for many purposes.

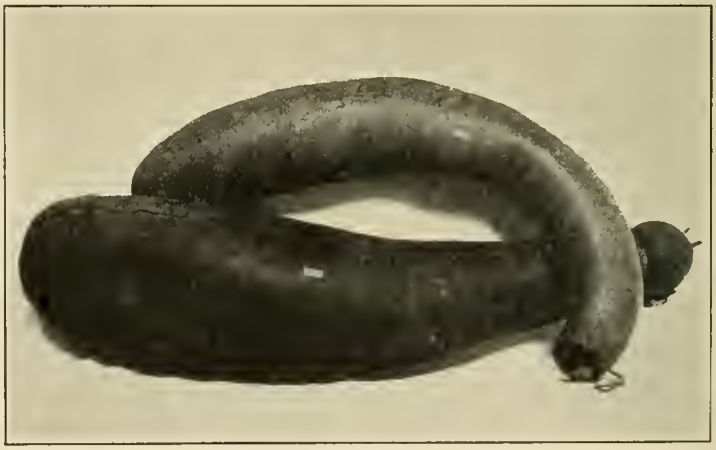


FIG. 118. LONG GOURD BOXES.

Gourd Boxes.—The thicker gourds were fashioned in such a way as to be tolerably tight so they could be used to store feather work or choice kapas. Such a box is shown in Fig. 117. This is 63 inches in circumference and 16 inches high, and it will be noticed that the cover is cut from the shell with two projections or wings, and this can be kept in place by cords passing through the drilled holes, two on each side. Such boxes were used for storage rather than traveling, in which the thinner gourds, illustrated in Fig. 114, were preferred. I do not know how the thick shelled varieties were produced, but the substance between the inner and outer skins is fairly dense, perhaps more so than in the thin varieties, which are often eaten by white ants which destroy nearly the whole median tissue.

Long thin varieties of this Curcubita were also used for storage of the feather capes and leis, and were sometimes so curved that they could be hung over a beam or rafter. Two of these long boxes, now in this Museum, are shown on Fig. 118. Gourds that were in form and size between the large bowls and these long boxes were in demand for hula drums (Fig. 119), and few houses of the alii were not provided with some of these popular instruments for beating time for the hula dance.

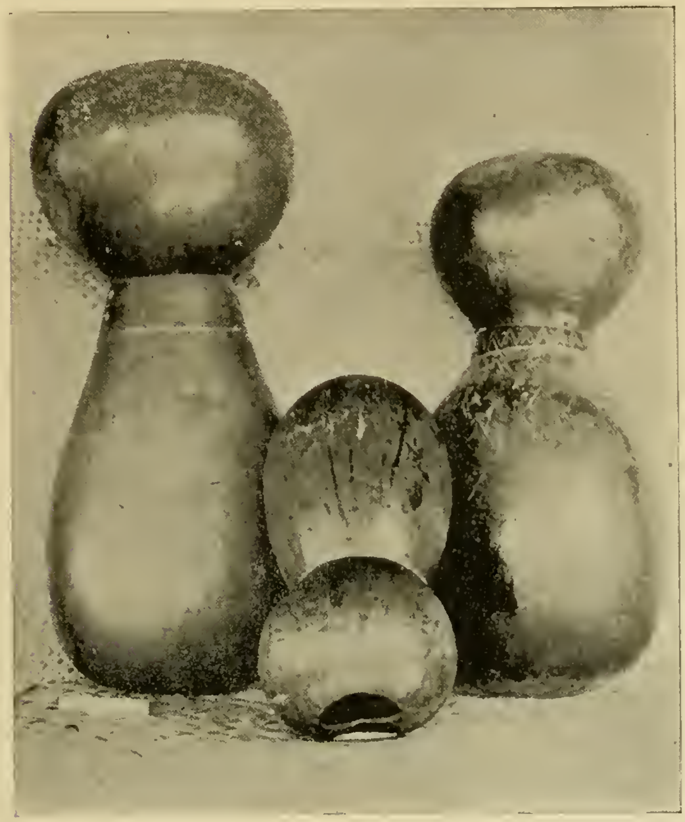


FIG. 119. GOURD HULA DRUMS.

From the bottle-gourds were made, besides the bottles, an endless variety of conveniences, some of which were so common as to demand notice, while others were local and trivial and may be passed by. But the bottles themselves varied greatly: there were the almost globular ones with a very short neck, handy on a journey; the long necked ones for household use, and the hour-glass shaped ones which were easily carried by a cord passed around the constriction, while the others had to be provided with a net or sling. The fishermen's huewai were long and almost without necks, that they might be laid on the bottom of the canoes out of the way. These are shown in Fig. 120. An unique form has been shown in a previous part of the Museum Memoirs,[72] in which compression had been applied to the growing gourd by means of a net, and the bulbous portion, to which alone the pressure was applied, was forced into round protuberances which, as may be seen by referring to the figure, were decidedly ornamental.

---

[72] Old Hawaiian Carvings found in a Cave on the Island of Hawaii. Memoirs II, No. 2. The gourd bottle is figured on p. 17 (170) and here reproduced, Fig. 121.

To stop the mouth of a water bottle the Hawaiians used a Terebra shell, a small cachelot tooth, or a neatly folded palm or pandanus leaf fragment. To the present day these gourd bottles are in demand, although hard to find, for carrying water while on a mountain tramp, for they are light and keep the water cooler than the ordinary tin canteen.

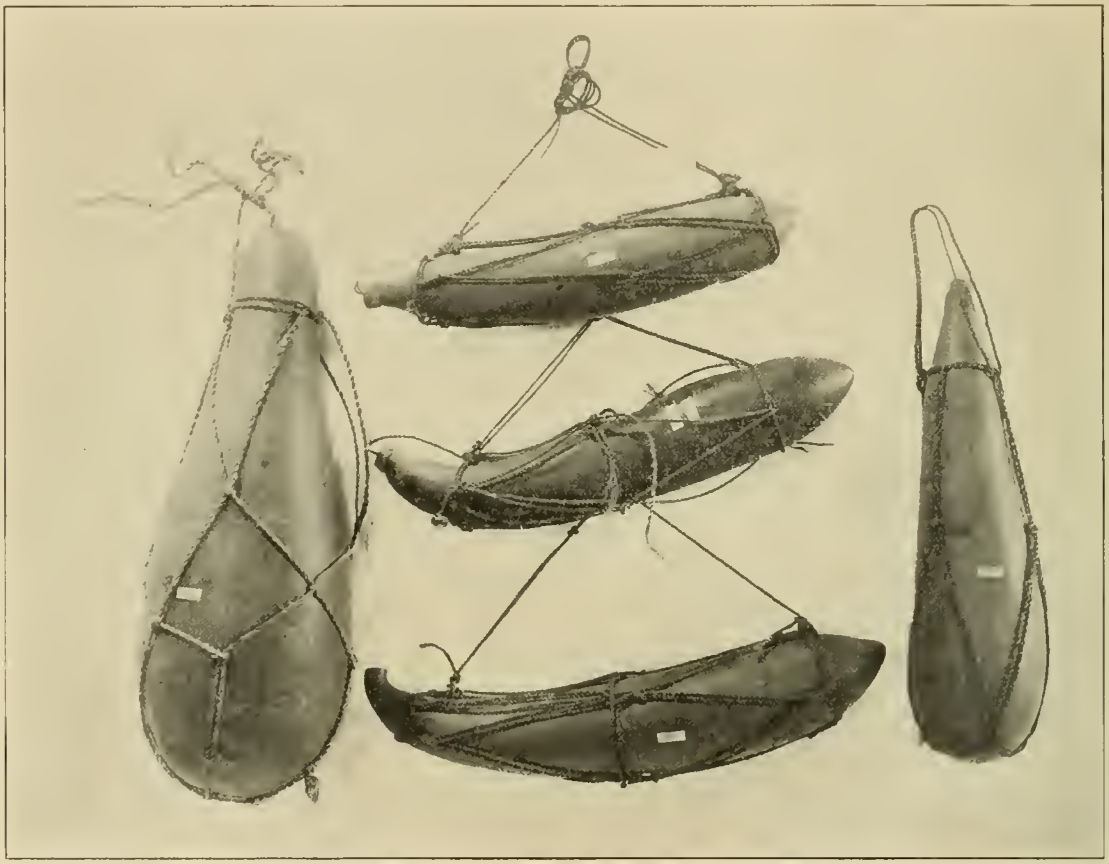


FIG. 120. GOURD WATER BOTTLES FOR CANOES.

Funnels.—The necks of the huewai are often so long and slender that one perforce admires the patience exercised in originally emptying the gourd through so long and restricted a passage: especially when it is remembered that after rotting the pulp and farther disintegrating the softer portions of the shell by shaking in it the small pebbles that took the place filled by shot in washing glass bottles, the whole resulting mass of pulp, pebbles and seeds had to pass out of an aperture often less than three-eighths of an inch in diameter. To fill such a bottle with water required a funnel, and the gourd furnished these of two general forms as shown in Fig. 122. One (1231) was a segment of a bottle, a little less than half, the lower part of the neck serving as spout; the other (1230) was a bottle with a disk removed from the bottom to form the mouth of the funnel. The first time I saw one of these bottles filled, however, was without any funnel. All along the coast of Oahu, east of Diamond Head, springs of fresh water are found below the sea level, and near Leahi one of considerable size and force of current exists. My native diver placed his thumb over the neck of his empty huewai, plunged into the sea and soon emerged with a bottle full of sweet water. The process used to be common before the Nuuanu waters were brought over the town of Honolulu.

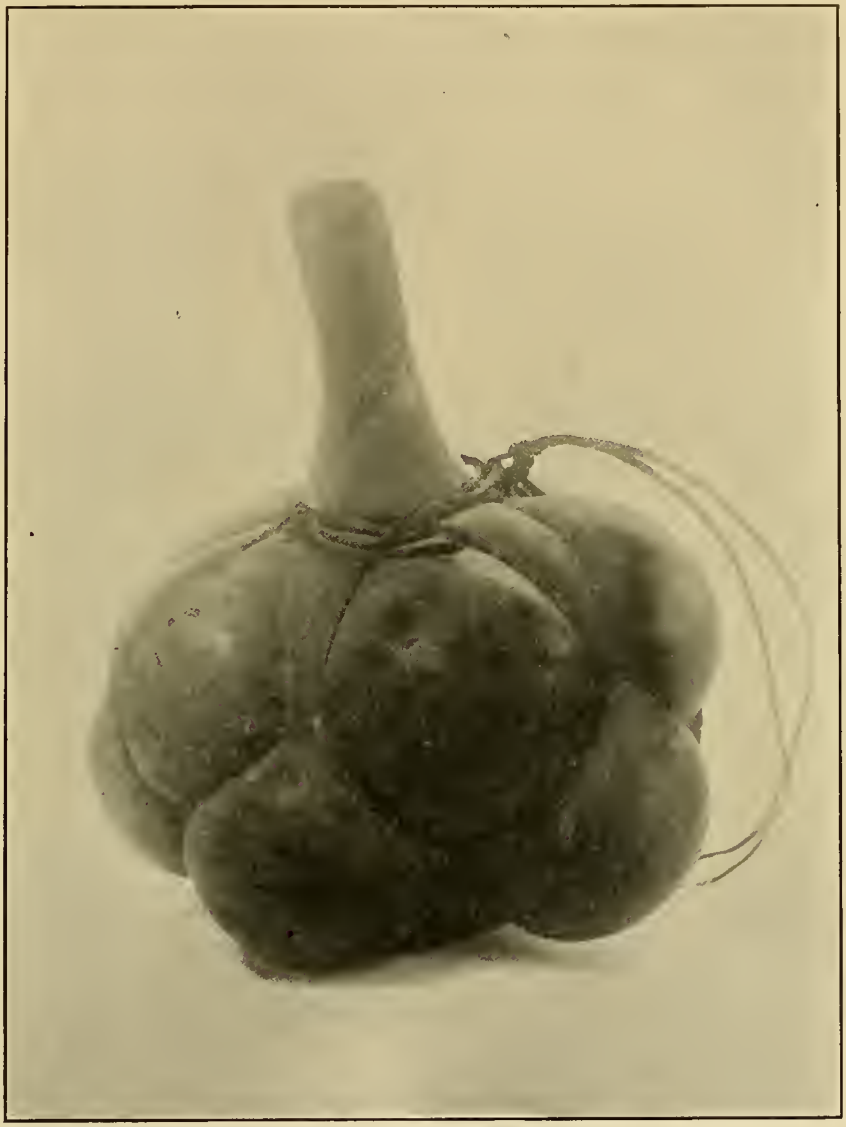


FIG. 121. COMPRESSED GOURD WATER BOTTLE.

Strainers.—Awa drinking was neither so universal on the Hawaiian Islands as on the southern groups, nor attended with so many ceremonies, but as the same process of chewing the peppery root and washing the masticated mass with water was followed, it was of course necessary to strain out the woody fibre from the green liquor, and there were three implements used as convenience served. First the funnel shown at the left in Fig. 122 could be partly filled with vegetable fibre and the liquor poured through this; second, a special strainer was made from a gourd bottle as shown in Fig. 123, the neck being loosely filled with fibre. The third was perhaps the most ancient form and was a coconut cup with the "eyes" enlarged slightly, as may be seen in the illustration of coconut cups, Fig. 128, upper cup.

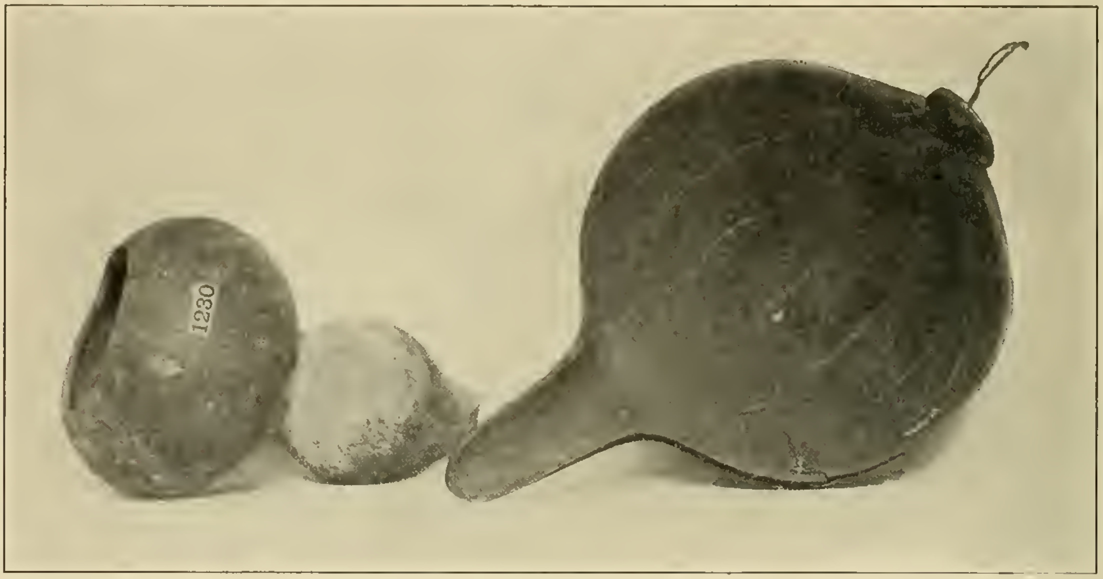


FIG. 122. GOURD FUNNELS.

Ipu Pawehe.—The instinct of surface decoration, rather Papuan than Polynesian, displayed itself on these gourd vessels as well as on the kapa or bark paper, and we have both *umeke pawehe* and *huewai pawehe*, bowls decorated and water bottles decorated: a fact that testifies to the esteem in which these fragile articles,—a sort of vegetable faience,—were held. Plate XXXVI will show the nature of this bichromatic design as applied to the umeke, in black and one of the various shades of orange-brown. In old specimens the orange is so deep that it is difficult, if not impossible to obtain by photography the distinction between pattern and ground, even with all the refinements of ray filters and plates especially sensitive to the orange rays.

The process by which this coloration was obtained was simple, but is variously described by the authors who have noticed the decoration. Malo's account we have given: my notes from the makers of huewai pawehe of half a century ago give it as follows: The portion to be left of the natural color of the gourd was covered with a varnish or glaze impervious to water, and the parts to be colored black were then scraped bare and the vessel immersed for a season in the mud of a kalo pond: a sort of etching process. I confess on examining some of the fine specimens in this Museum I do not see how this proceeding could produce such results, and I will quote from Rev. William Ellis:[73]

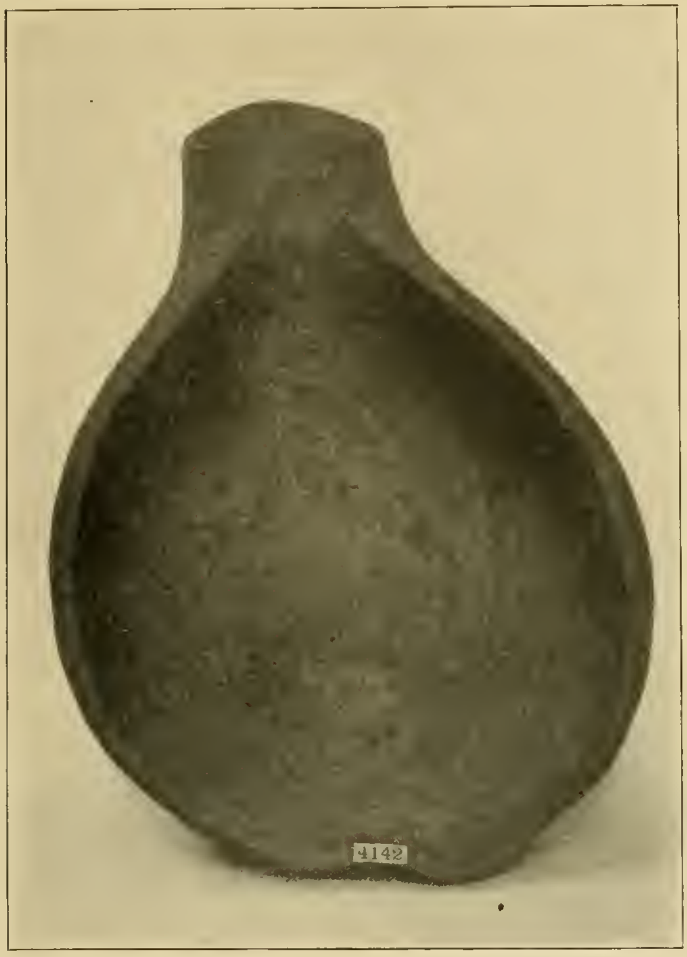


FIG. 123. GOURD AWA STRAINER.

> When the calabash is grown to its full size, they empty it in the usual manner, by placing it in the sun till the inside is decayed, and may be shaken out. The shell, which remains entire, except the small perforation made at the stalk for the purpose of discharging its contents, and serving as a mouth to the vessel, is, when the calabash is large, sometimes half an inch thick. In order to stain it, they mix several bruised herbs, principally the stalks and leaves of the arum, and a quantity of dark ferruginous earth, with water, and fill the vessel with it. They then draw with a piece of hard wood or stone on the outside of the calabash whatever figures they wish to ornament it with. These are various being either rhomboids, stars, circles, or wave and straight lines, in separate sections, or crossing each other at right angles, generally marked with a great degree of accuracy and taste. After this coloring matter has remained three or four days in the calabashes, they are put into a native oven[74] and baked. When they are taken out, all the parts previously marked appear beautifully brown or black, while those places where the skin has not been broken, retain their natural bright yellow colour. The dye is now emptied out, and the calabash dried in the sun; the whole of the outside appears perfectly smooth and shining, while the colours imparted by the above process remain indelible.

---

[73] Tour of Hawaii, second edition, p. 376.

[74] This imu or oven consists of an excavation in the ground lined and generally floored also with stones. A fire is kept up in this until the stones are very hot, when the articles to be cooked are put in the place of the fire, wrapped in ki leaves, and the coals and hot stones piled about the deposit which is then covered with earth and mats and left for some time. The result, if the oven is properly timed, is excellent. New Englanders will recognize the method of their clam-bake, which was learned from the Amerind.

The huewai shown in Fig. 124 are modern, and the maker does not seem to have attained the full black dye of the older artisans. These ipu pawehe are rare in museums, and this Museum is fortunate in possessing a very full series of these decorated gourds, which were mostly the property of the alii. The black of the olden time seems durable, but the orange of the gourd is blackened in the tropical sun and also by the oil which was sure to get on them from the oiled hair and bodies of the natives. Plate XXXVI shows some of the best of the umeke pawehe, and also some of the huewai. This form of decoration is found also on the hula drums (Fig. 119, used for beating time to the dance) which were made of large specimens of Curcubita, and the resemblance to tatuing is close; the figures on the huewai in Fig. 124 are quite like the tatu patterns formerly impressed on Hawaiian limbs.

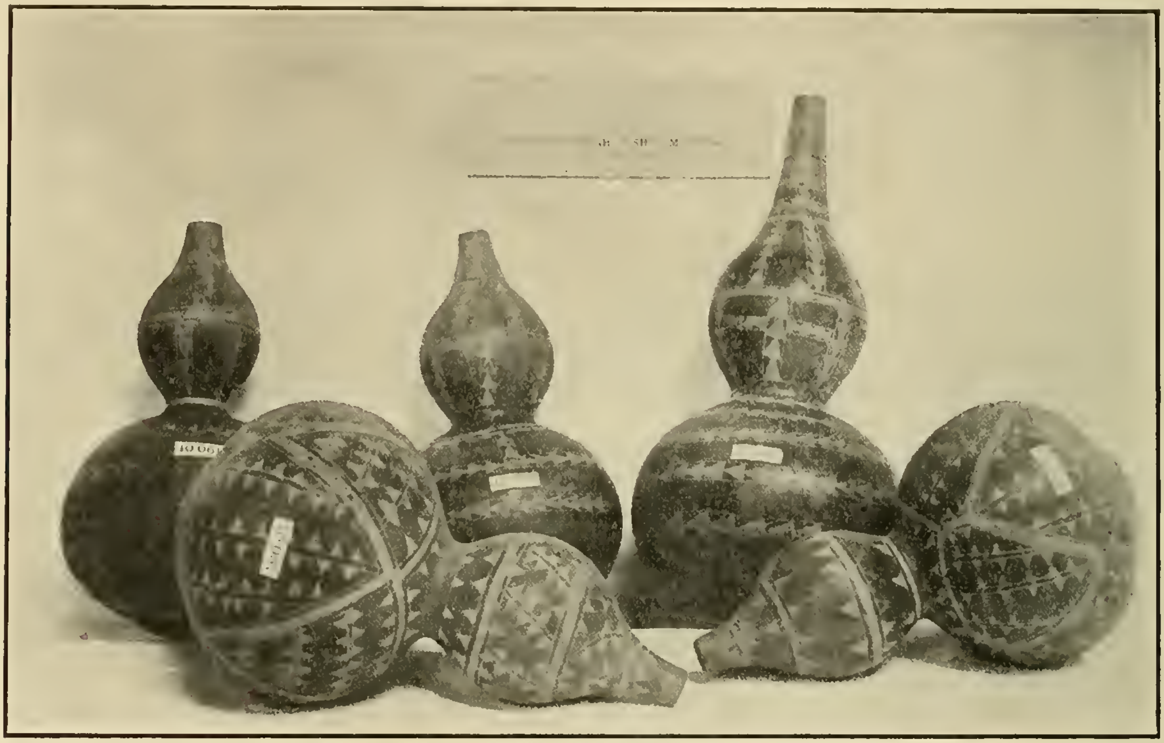


FIG. 124. HUEWAI PAWEHE.

The uses of gourds were too extensive to describe fully in a treatise on house furniture, but it may be mentioned that a form was used as an injection syringe (Fig. 125, A); the neck of a broken bottle was used as a reel for a fish-line (B); another portion in shape of a funnel was the principal implement in a game of toss (C); small gourds were filled with pebbles (D) and used as rattles (*uliuli hula*) or in the dance as castanets, and finally the fragments were used as Job used the potsherds when afflicted with furunculi. Truly the gourd was a most useful adjunct to the furnishing of a native house! The cultivation of this vegetable, once very extensive, had, in the early sixties, dwindled to a few places in Puna, Hawaii, and as many on the southerly shores of Kauai, and is now nearly extinct on this group. The Lagenaria has lasted longer than the Curcubita.

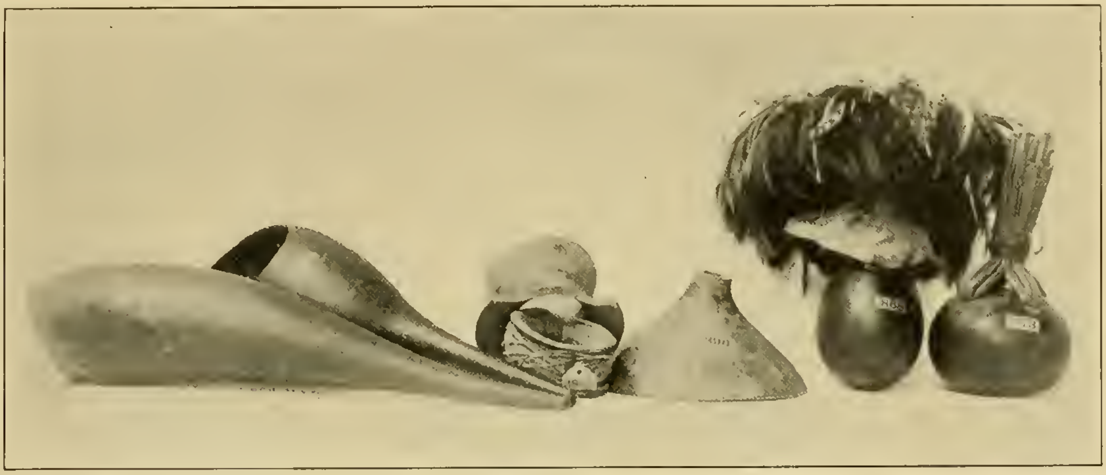

A B C D

FIG. 125. GOURD IMPLEMENTS.

Coconut Utensils.—The fruit of the Coco palm has been several times referred to, and we may now examine some of the many uses this nut serves in the domestic economy of the Hawaiian. Little was peculiar to this people for the coconut is so widely spread through the tropics that many other races have exhausted their ingenuity in devising implements from the hard, durable shell of the coconut. Still it is well to show what the Hawaiians did with this material. First, probably the nuts served as water-bottles, as they still do in many parts of the Pacific, especially in the southern groups where they attain a greater size than on Hawaii. There is one in this Museum from Samoa that has capacity of ninety-two ounces or nearly three quarts. Not less ancient was their use as drinking cups, and the Hawaiians made a distinction between ordinary cups (*apu niu*) and those exclusively for the use of the priests to which the name *olo* was given. The former were cut at right angles to the vertical axis while the latter were cut parallel to this determinant: both forms are shown in Fig. 126. A coconut cup was the orthodox form for awa drinking, and such cups by long use gather a fine *patina* which is as much valued by awa experts as the rich color of a meerschaum pipe by its smoker. Although coconut cups are often

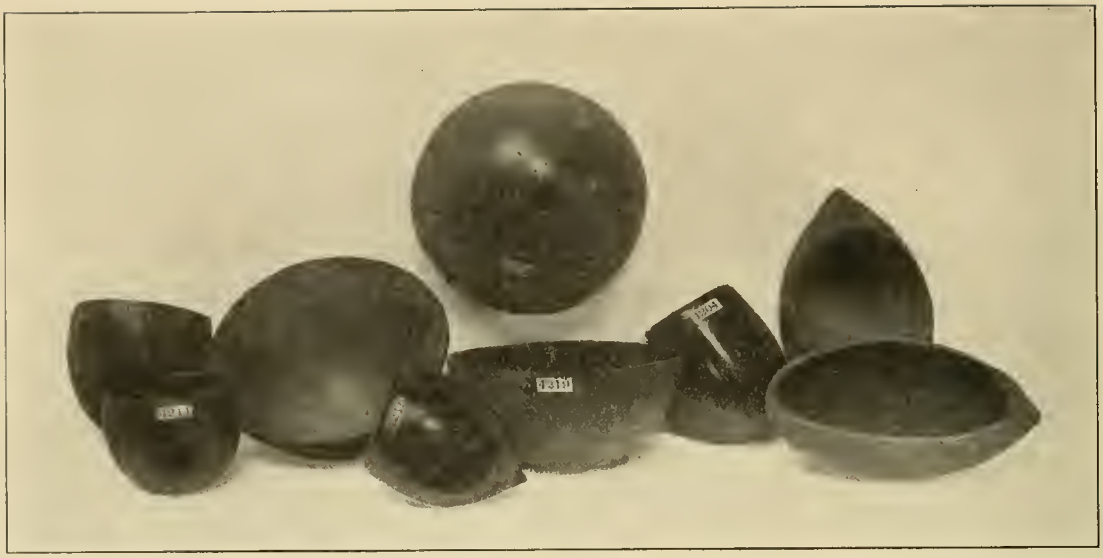


FIG. 126. COCONUT CUPS.

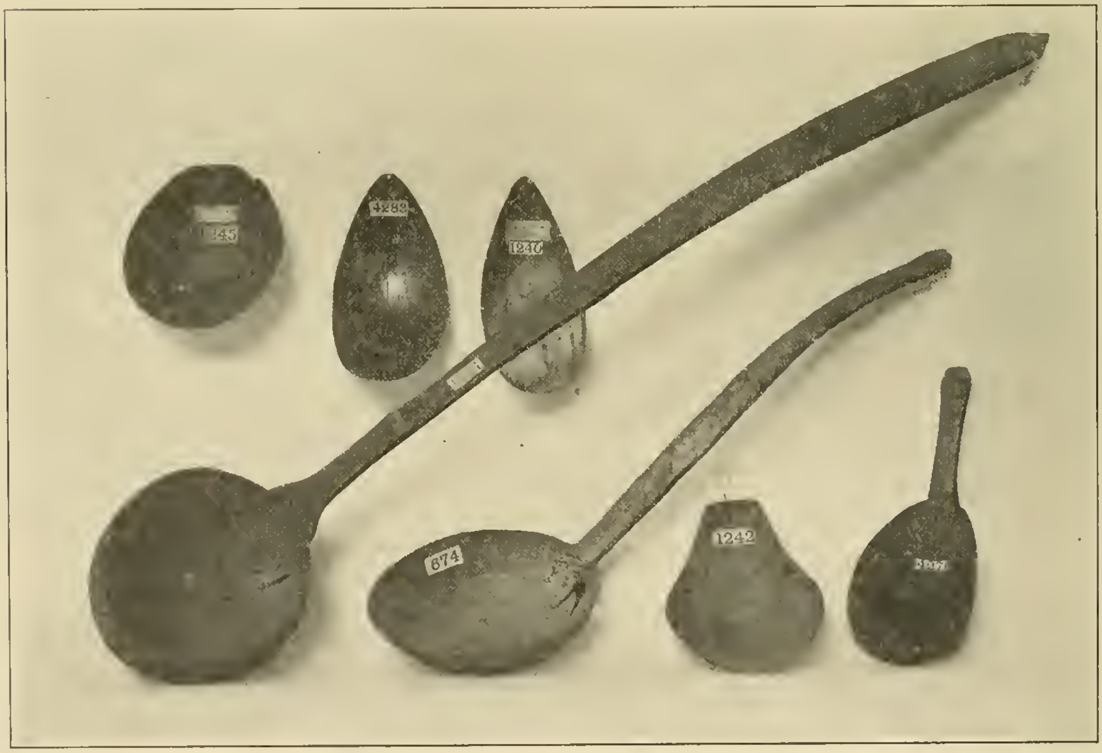

4283
1240
674
1242

FIG. 127. COCONUT SPOONS AND LADLES.

found in the burial caves deposited with the dead, no decorated ones are known. The beautiful carving of the Marquesan, Fijian and others shown in Plate XXXVII and Fig. 128 is not found on Hawaii.

Next, perhaps, came the use of coconuts for spoons, filling a natural need, and almost any concave fragment served, but soon the handle was developed, and a very complete ladle (*ooma pu niu*) resulted. As the Hawaiians did not boil their food, and soups were unknown, this manufacture was not so important as in the groups where the discovery of pottery was followed by hot liquids. The indigenous products are shown in Fig. 127. In certain districts where the water supply was scarce and kalo could not be cultivated, the sweet potato (*uala maoli*) took its place as daily bread, but the resulting mass was wanting in the adhesive qualities of the kalo-made poi and could not be wound up on the fingers, so a spoon was needed, and the bits of coconut figured were and are still used to convey this food to the mouth. For salt cellars disks of the shell answered very well.

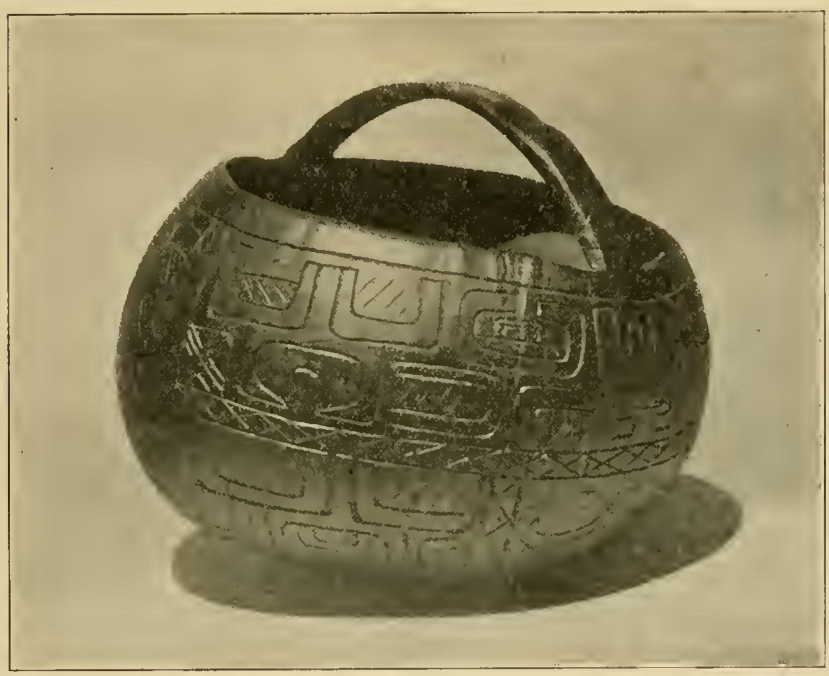


FIG. 128. MARQUESAN CARVED CUP.

As the coconut shell takes a beautiful polish the manufacture of cups, bowls and small dishes has been much modified under foreign influence. Among Hawaiians these polished nut cups, foreign even to the glue that unites the cup and base, the latter the work of the turner, are still popular for individual poi bowls at feasts. Their form is shown in Fig. 129 which presents four well made cups from the collection of the Princess Ruta Keelikolani now in this Museum. The first is one of the large southern nuts on a turned stand of kou wood; the second shows a cover and base also of the nut; the third is a well-proportioned cup and stand, and the last is one of the yellow variety of nut. Both the dark and light varieties of shell were esteemed, but the former takes the better polish; one in this Museum from the Society Islands is perhaps the most beautifully polished coconut I have seen.

Besides polishing, which is a comparatively modern fashion, the other groups furnish examples of inlaying most artistically and neatly done. The cannibals of the Solomon group have inlaid a simple coconut shell cup with crenate triangles of pearl shell in a way that would do credit to a civilized artisan who had never eaten his fellow man. The shell is hard and thin and the recesses cut for the inlay must be shallow, but the method of decoration is much used among the Solomon Islanders and they certainly understand their material (Fig. 130). On other Pacific groups much greater use was made of the coconut. How far the decoration of cups went, I cannot say, for I do not know of any collection to illustrate this, but certain specimens on hand in this Museum may be noticed. On the Fijian group a plain cup has an attachment of braided coir, so that one drinking from the cup could use this permanent napkin which could be washed with the cup (Fig. 131). On the Marquesas coconuts were often incised with the peculiar figures so much used there in tatuing and wood carving. Fig. 128 shows a cup or basket, if we consider the handle, which has a pleasing pattern surrounding the bowl. Similar to these are the Fijian carved cups and oil bottles shown in Plate XXXVII. The Papuans of New Guinea also carved their coconuts, and examples of their work are shown on the same plate. The latter coconuts seem to have a very thin shell, compared with the other nuts described.

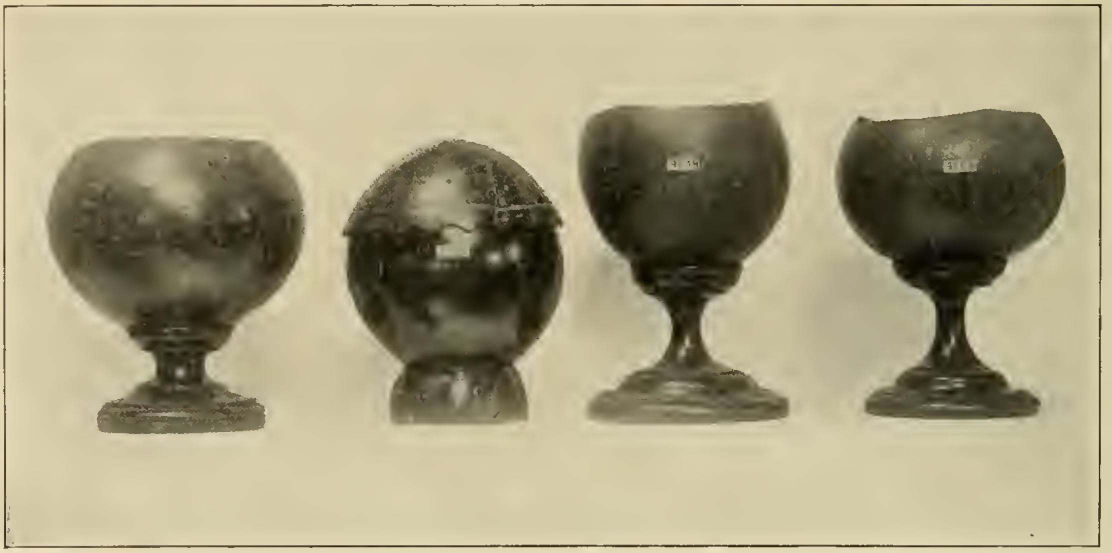


FIG. 129. MODERN COCONUT CUPS OF THE HAWAIIANS.

The Solomon Islanders had no bottle gourds and they supplied the want by an ingenious use of the coconut in which the material was completely disguised by coating the nut with a gum (*Parinarium?*), which cemented to a hole on the top a joint of bambu which was also coated with the same material. The result resembled pottery, and the nut portion was decorated with imbedded shells or beads forming patterns of great variety. Fig. 133 shows several of these bottles.

On the Micronesian groups, where coconuts are abundant and fresh water scarce, the nuts are used extensively for carrying and preserving water. The natural nut is cleaned out, the "eye" enlarged and plugged with a pandanus leaf tightly folded for a stopple and with the attachment of two cords of coconut fibre, the bottle is complete. Two are usually on the same cord, as shown in Fig. 132, for convenience of carrying. Other groups use the same contrivance, and I have found it on Samoa, Fiji and almost identical in Singapore, Akyab and western India.

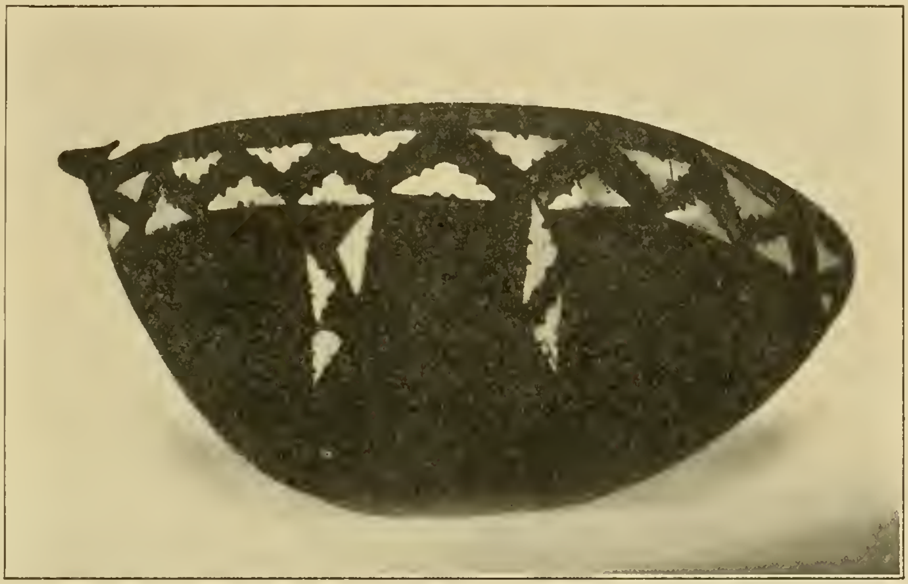


FIG. 130. SOLOMON ISLANDS CUP.

After the introduction of tobacco a small coconut shell became the favorite tobacco box (*hano baka*). A series of these in the Museum collection is shown in Fig. 134. The cups formed of the lower end of these long slender nuts were much in demand for mixing fish bait, while precisely the same thing was used in the Caroline Islands for moulding the cakes of red paint called *taik*. We must not forget that these nuts had part in the amusements of the Hawaiians, both as rattles (*uliuli hula*, Fig. 125, D) precisely as the small gourds were used, and as drums to be bound to the arms (*puniu hula*), but of these a more complete description belongs to the chapter on Amusements.

Here we may mention a pleasing custom of the Hawaiians which has survived within my own observation, for a chief to bend down a young coconut tree in token of taking possession, and ever afterwards the tree was known by the name of that chief, and on gathering the first nuts, the chief had them made into cups for presents to friends. Several such cups are in this Museum, as the cup of Pauahi, the mother of Keelikolani, that of Queen Kamamalu, and that of Liliha, Madame Boki and daughter of Hoapili: the last two cups were from the famous grove of palms at Kalapana on Hawaii.

The cups shown in Fig. 135 were such as described. Beginning on the left of the figure, No. 5016 was a cup of Pauahi, mother of Keelikolani; No. 1521 belonged to Liliha, daughter of Hoapili and wife of Boki. The next is No. 5028, an umeke kou used for poi by Queen Emma when a child. No. 1519 also belonged to Liliha; No. 5012 to Pauahi; No. 1520 to Liliha, and the last one, No. 5017, belonged to Queen Kamamalu, daughter of Kamehameha I, who with her husband Liholiho died in England in 1824.

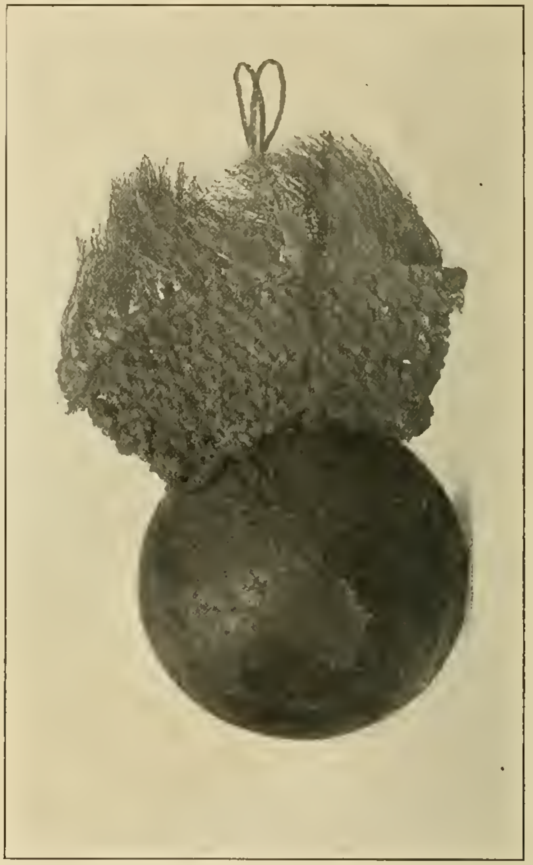


FIG. 131. FIJIAN CUP AND WIPER.

Umeke Laau.—Implements of wood were by far the most interesting as well as most numerous of all the domestic utensils in Hawaiian housekeeping, and we shall find much to surprise us and not a little to commend. From their material they were more durable than the vessels of gourd; from the labor bestowed upon them they were proportionately valued; and like the precious feather work were preserved in families, and handed down from generation to generation, until the foreigner has come to the Islands and appreciating the workmanship and grace, has tried to imitate them on the lathe, but with poor success and has ended in gathering to himself the choicest remains of this "Age of Wood", and a genuine hand-made umeke is now a rare and costly treasure; fine ones have been sold for more than five hundred dollars.

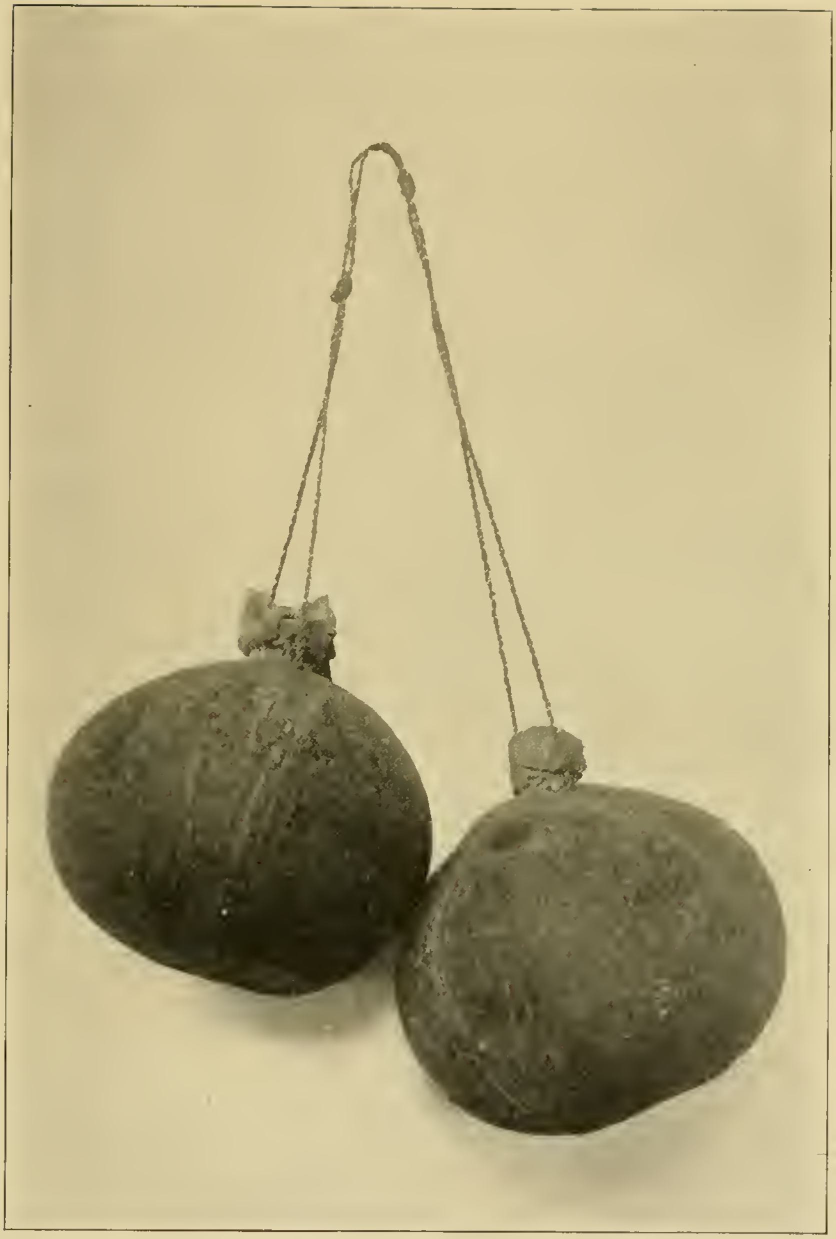


FIG. 132. MICRONESIAN WATER BOTTLES.

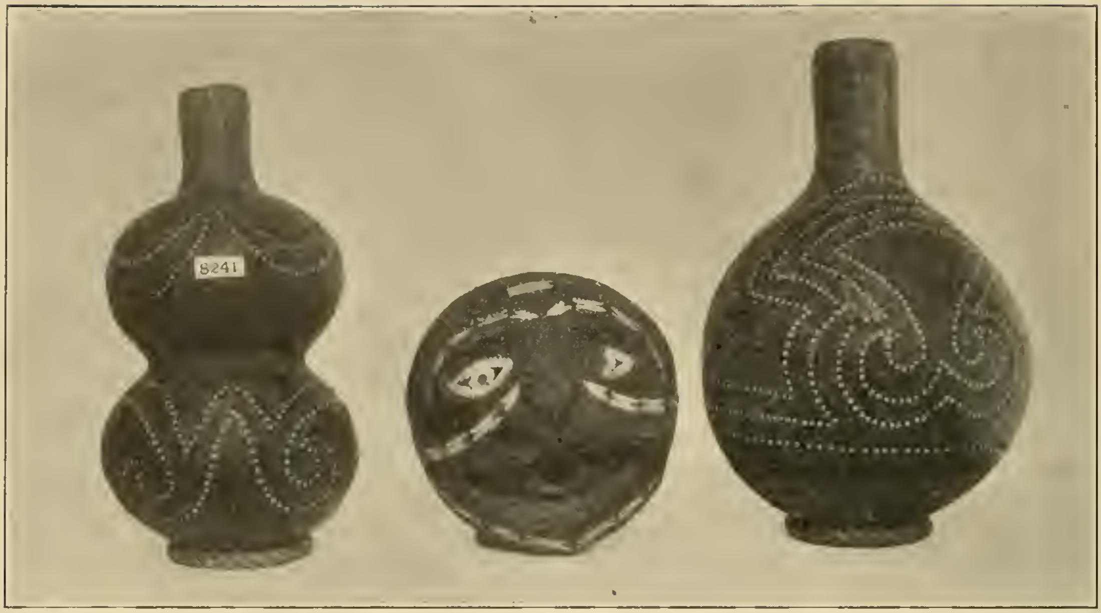


FIG. 133. SOLOMON ISLANDS COCONUT BOTTLES.

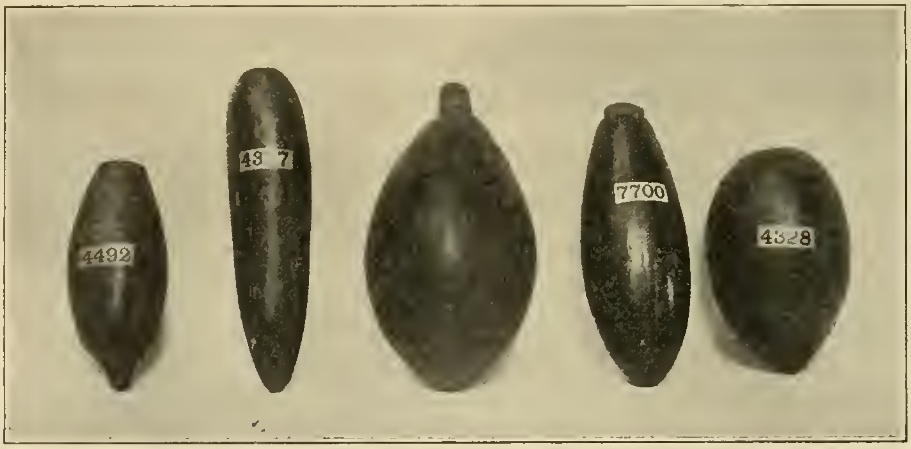

4492
43 7
7700
4328

FIG. 134. COCONUT TOBACCO BOXES.

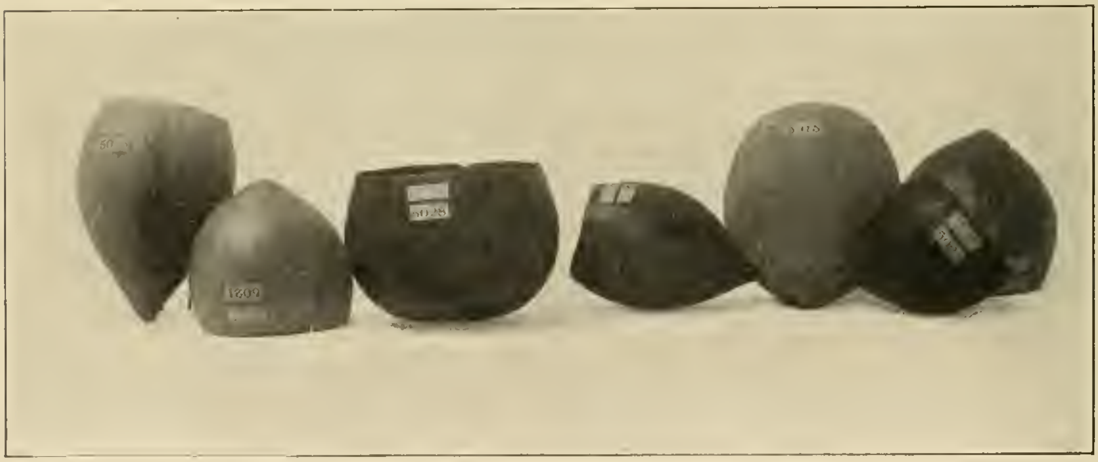


FIG. 135. COCONUT CUPS OF THE HIGH CHIEFS.

In no one thing has the artistic taste of the old Hawaiian come into closer touch with the best taste of older civilized nations than in the making of wooden bowls. Unlike the Maori, who carefully kept and honored the memory of the artists among them whose carving was good, the Hawaiian has not preserved a single name of those who patiently with stone tools fashioned the umeke, plain or grotesquely carved, that have come down to us. The Maori sculptor made astonishing relief work as we have seen in the portions of houses and figures already illustrated in these pages; his carved bowls or dishes were curious, some of them so close in motive to some of the Hawaiian dishes that I shall show later a Maori dish that closely resembles a favorite Hawaiian form; but when we look through his bowls, dishes and general household utensils we shall find nothing to compare with some of the Hawaiian umeke, and if we extend our examination through the other groups the result will be the same. Grotesque and most interesting work we shall find in New Guinea and the Solomon Islands, very original dishes on the little Matty Island, but these Papuans had pottery to make bowls and dishes which would parallel the uses of the Hawaiian umeke. The Admiralty Islanders made huge bowls, but their decorations were more striking than their shapes. The Marquesans made bowls after the general form of the Hawaiians but with none of the finish. Perhaps if we knew more of these and other groups, and had adequate collections of the work in this class that each has in the past fabricated,—for this is all past now,—our judgment might be modified; but in the absence of sufficient explora-

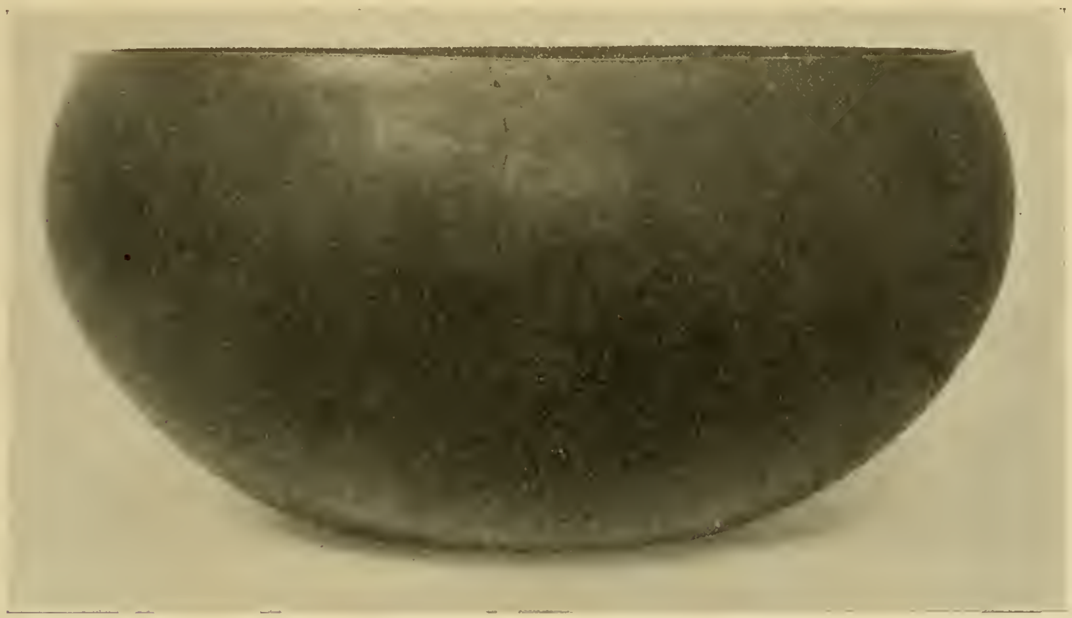


FIG. 136. UMEKE NO. 416: VERY OLD.

tion, in a few years useless, if the appointed time be not already passed, we are compelled to base our judgment on the collections in museums. From these sources, with the extensive material of the Bishop Museum at hand, and beautiful photographs of the Salem Museum, and other great collections before us, we feel justified in placing the unknown Hawaiian carver of umeke high among the departed artists of the Pacific region, and so far as illustrations go, the reader can see the quality of their work for himself. They not only excelled in form, which is unfortunately the only quality we can present to our readers in the illustration, but they worked in wood of most agreeable colors and markings and capable of a most exquisite polish: the latter quality was one not present to the old Hawaiians, who attained a fine, smooth finish in the manner to be described later, but never the glassy polish dear to many collectors of this ware, and which, although an anachronism it must be confessed displays the beautiful markings of the wood perfectly.

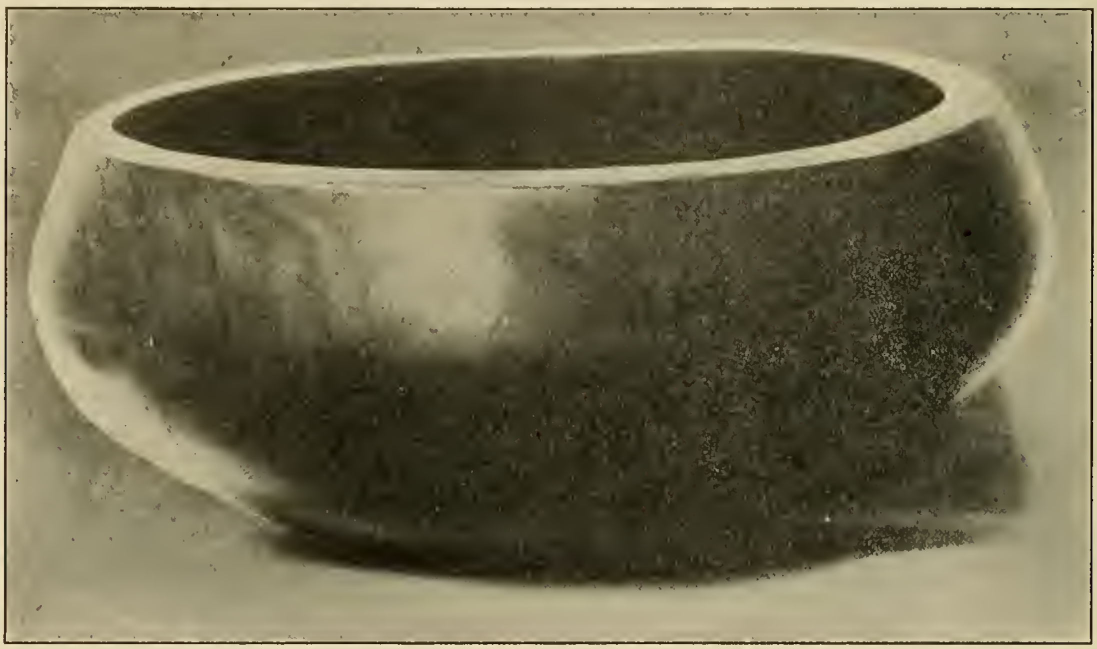


FIG. 137. UMEKE NO. 417: VERY OLD.

Among the woods most commonly used was the *kou* (*Cordia subcordata*) a littoral tree of large growth and spreading habit, found as far south of the equator as Madagascar, and formerly planted near the native houses along the beach for its grateful shade, but seldom seen now, owing to the ravages of a small moth *Azinis hilarella*=*Ethmia colorella* W. It is almost extinct on this group. The opinion of some botanists is that it has been introduced, but if so it must have been in very early time in the history of the people, as the ancient songs often mention the kou. The size the tree attains is shown by an umeke in this Museum which is nine feet in circumference, and of course made of the heartwood. To fell such a tree with a stone axehead weighing, it may be, ten pounds, must have required patience as well as muscle in the doing. Some of the oldest umeke in existence, which have been found in long ago closed burial caves are of this rather soft but durable wood.

Another tree the *Milo* (*Thespesia populnea*) has the same geographical range as the kou, the same habitat, and like the former tree is passing away and is seldom seen out of gardens, while a century ago it was planted about the houses of the alii, as is well remembered around that of Kamehameha the Great at Waikiki. Even the name is the same on the southeastern groups, where it was almost a sacred tree. It is a smaller tree than the kou, hence we have no large umekes from its wood, but there are very choice small bowls or cups. Its distinguishing feature is a rich peach color and under polish a translucent agate-like appearance.

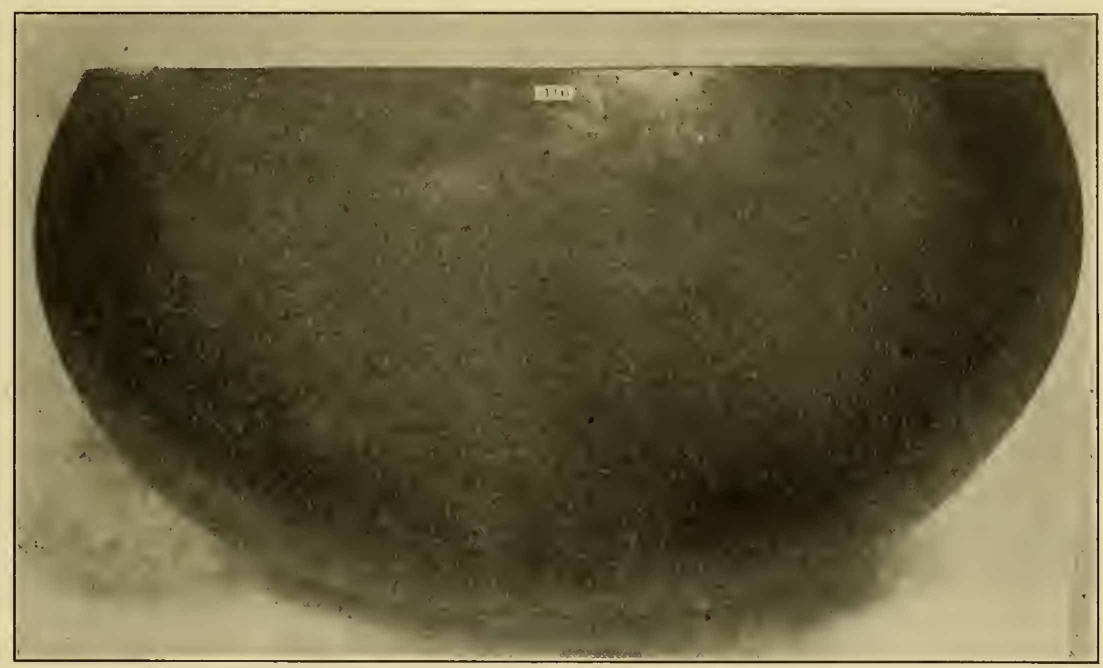


FIG. 138. UMEKE NO. 410: VERY OLD.

Another beautiful and durable wood is the *Kamani* (*Calophyllum inophyllum*), a tree found all through tropical Asia and the Polynesian islands and used on Hawaii to some extent for umekes. The tree itself is even more beautiful than its wood, and its glossy leaves and sweet-scented flowers caused the old Hawaiians to plant it near their houses while other Polynesians attached a semi-sacred character to groves of the tree, of which we find a trace in the sacred grove near the Puhonua or place of refuge at Halawa at the east end of Molokai.[75] The wood is of a brighter color than the kou.

The heart wood of the coconut was sometimes used for umeke, but those in collections of genuine old umeke would not amount to more than five per cent. of the whole number. When polished, coconut wood was very striking, but the old Hawaiians never carried their polishing far enough to bring out the full effect, and when unpolished the effect is dull in the extreme.

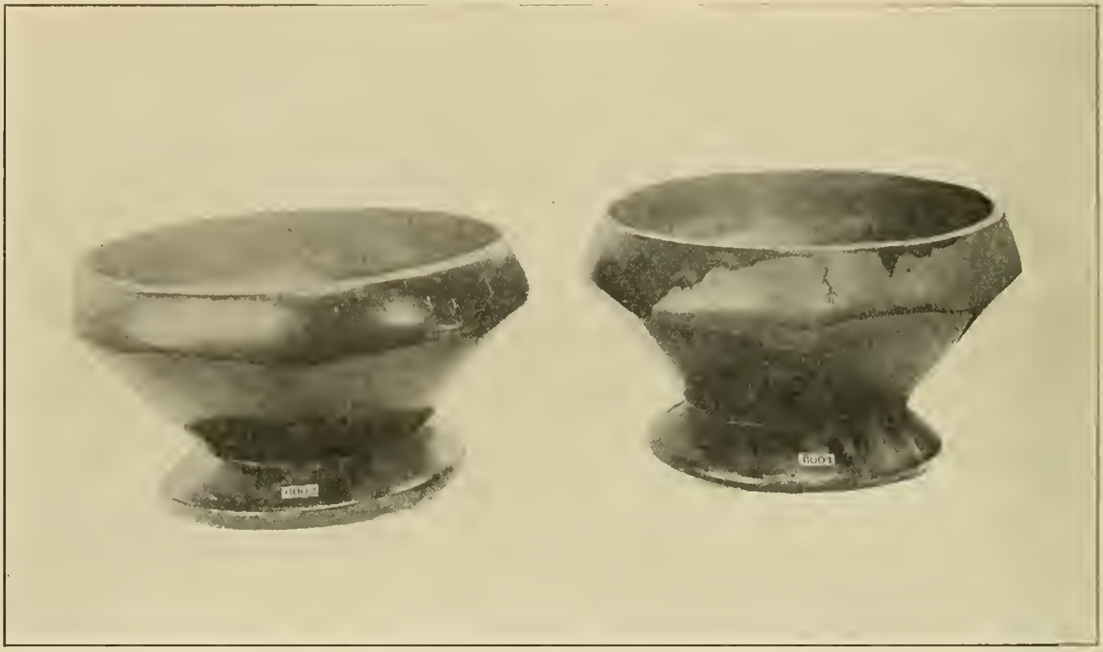


FIG. 139. UMEKE OPAKA OF KOU WOOD: NOS. 6003, 6004.

The *Neneleau* (*Rhus semialata*) is usually a small tree but at times attains a considerable diameter. In the Bishop Museum is a bowl of this wood (No. 1051) 14.5 inches in diameter. This wood is plain and close grained.

A more common material for wooden bowls of the less important sort was the *ohia* (*Metrosideros polymorpha*) of which the wood was hard and durable and much used for house building, the black variety for idols, and at the present day for railroad ties and fuel. See Plate XXXVIII for a choice umeke of this wood. In modern times the showy but coarse-grained and soft wood of the Monkey pod (*Pithecolobium siamang*) has been much used for bowls and other vessels.

---

[75] Hillebrand was mistaken in stating that this grove *formerly* existed. In 1890 it was in a flourishing condition, except that it needed thinning out, and I transplanted several seedlings to my garden in Nuuanu valley in Honolulu, where they flourish and one has attained in seventeen years to a height of about thirty feet and a girth of forty-seven inches a foot above the ground.

Technique of Bowl Carving.—Although they did not always succeed, as we see from the many cracks mended in the old bowls, the Hawaiian skilled in wood working tried to season his wood thoroughly by cutting it into suitable blocks and then sinking it in some pool where it might soak for months. When a dark tone was desired, the block was sunk in the mud of a kalo patch where the ferruginous mud soon produced the appearance of age even on light colored wood fresh from the maker's hand.

When sufficiently seasoned the block was shaped outside as a solid object as may be seen in Fig. 140. We are exceedingly fortunate in having a good series of half-shaped blocks in the Museum collections. A few years ago, when Hon. Chas. R. Bishop was having some excavations made on his estate at Waikiki the laborers dug from the sand a number of such blocks, some of which are shown in the figure, so many indeed, that it was evident they had been intentionally buried. Probably at the approach of Kamehameha's hostile fleet, the artisan in bowls hurriedly buried his whole stock in the soft sand for safety: either he was killed in the fight or forgot the place of concealment, for the cache was left for another generation to study and spell out the way of working. Another specimen of a deep umeke (No. 8571), fashioned externally but only half excavated was given to the Museum by Mr. Henry G. K. Lyman: in this it is easy to see how the pecking out of the core was done.

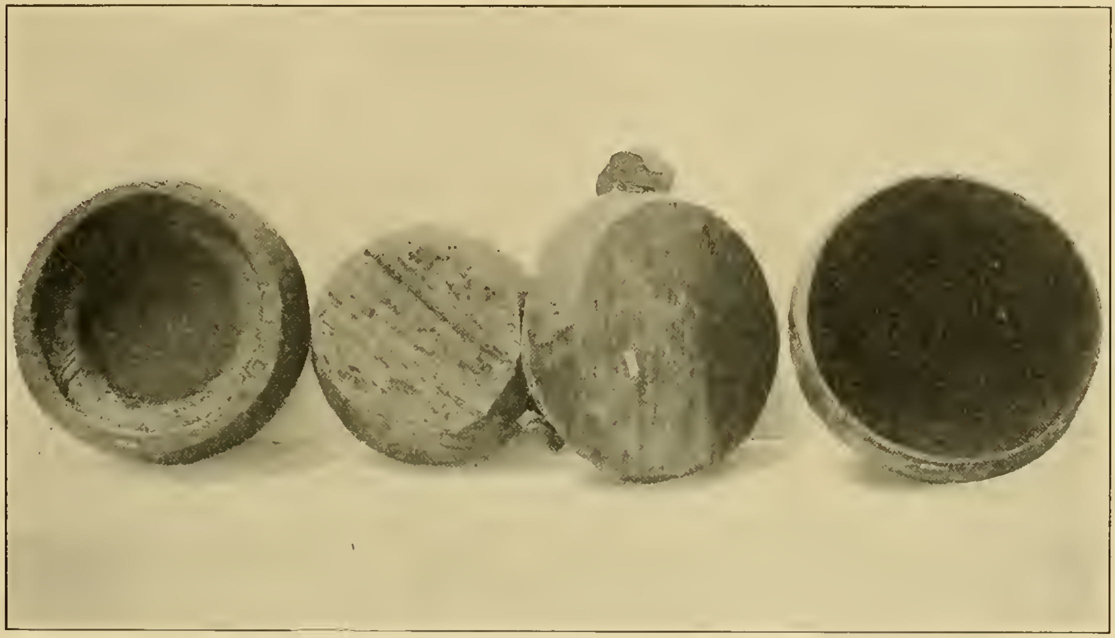


FIG. 140. BLOCKS PARTLY SHAPED PERHAPS A CENTURY AGO.

It will be at once asked by the turner of modern times how they managed to strike a circle? There are no signs of any circle struck on the flat surface, and all the specimens show, what can be seen in those figured, that the rough block was only approximately circular, and it seems certain that the final rotundity was given by the accurate eye of the artisan. Whether the result of warping or not, the accurate measurements of the genuine old umeke always detect a small deviation from the circle which can sometimes be seen by the eye. They however used for preliminary measures a flat strip of bambu which also served for a "straight edge" or rule: I have never seen one of these bambu rules graduated or marked in any definite way.

In excavating the inside it is curious to note how they adopted the method of the modern turner as shown in the first bowl in the figure, where an excavation was carried to a certain depth then an inner concentric circle was dug out in proportion to the outside curvature, and finally the angular benches were dug or grated down to the final surface. In all cases where a handle was desired a part of the block was left for that purpose, a thing the turner cannot do: he must carve his handle in a separate piece and glue or pin it on. In some of the old *ipu kuha* or spittoons found in burial caves and supposed to be of considerable antiquity this handle is of slight projection, in others has been bored for a string at some time subsequent to its original making, for the bore is rough and of inferior workmanship: these handles can be compared in the plate where many ipu kuha are photographed. (Plate XXXII.)

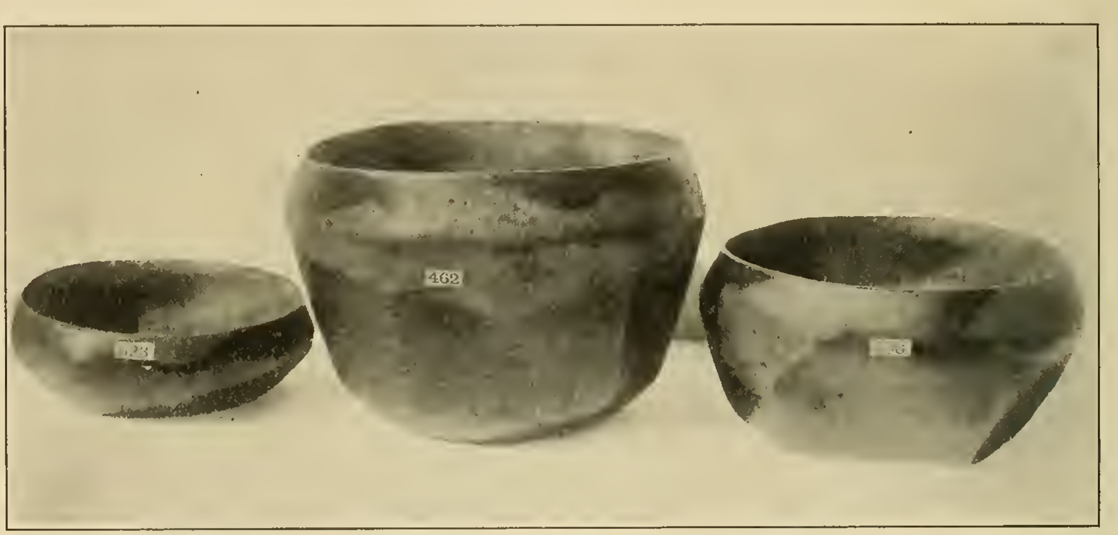


FIG. 141. OPAKA OR POLYHEDRAL UMEKE: 523–488.

In some of these half-made bowls, I think I can detect the mark of a small, sharp adze, and again the marks of a stone chisel, but the tool which seems to a modern amateur carpenter most efficient, the shark tooth cutter, does not appear to have been used on these blocks. It was, however, the favorite tool of the carver of figures.

A more difficult feat than shaping a circular bowl was making a polyhedral bowl. These are rare, and were evidently valued as they are found only in the possession of chiefs or their descendants. Those shown in Fig. 141 belonged to the Kamehameha family and from them came directly to this Museum. The sides are closely equal and beautifully finished, the flat surfaces fading into the curved ones in a most graceful manner.

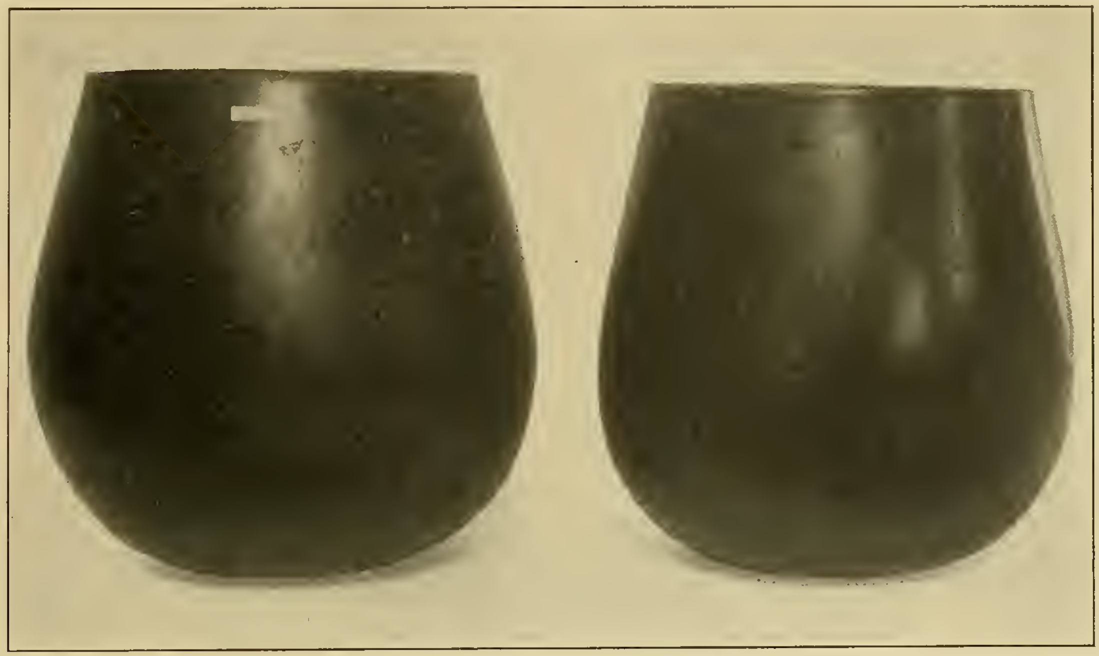


FIG. 142. DEEP UMEKE.

In size the Hawaiian umeke varied greatly as shown in Fig. 148 where the central one has a circumference of 74 inches and a height of 20 inches. The largest one in the Museum is 89.5 inches in circumference and 19.5 inches high, and natives claim that there are larger ones, but I have not seen them. A modern turner would have some trouble to handle a block of such size, and yet the old Hawaiian cut down his tree with his stone adze, shaped his block with the same implement of smaller size, and finally with stone dug out the core. In depth also they varied greatly. Some were hardly more than round platters, while others were deep in proportion to their diameter as two to one. Fig. 142 shows two of the deeper ones, the first belonging to the Museum, the other to the family of the late Chief Justice Judd. There is another much deeper, formerly in the palace, and said to be the *Ipu makani* of Laomaomao the Hawaiian Æolus, in which he kept his winds. Many of these deep umeke had thick

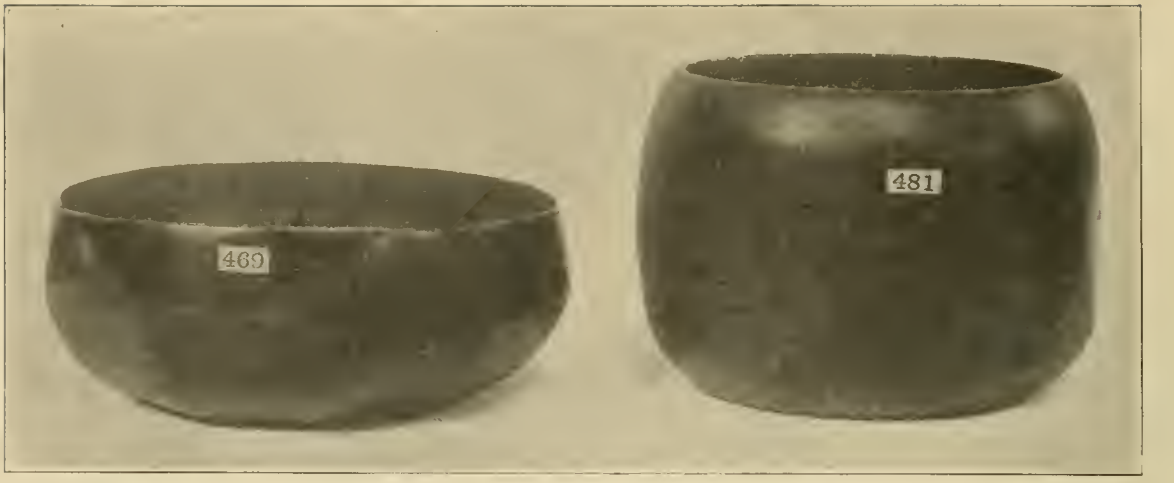


FIG. 143. UMEKE NOS. 469 AND 481.

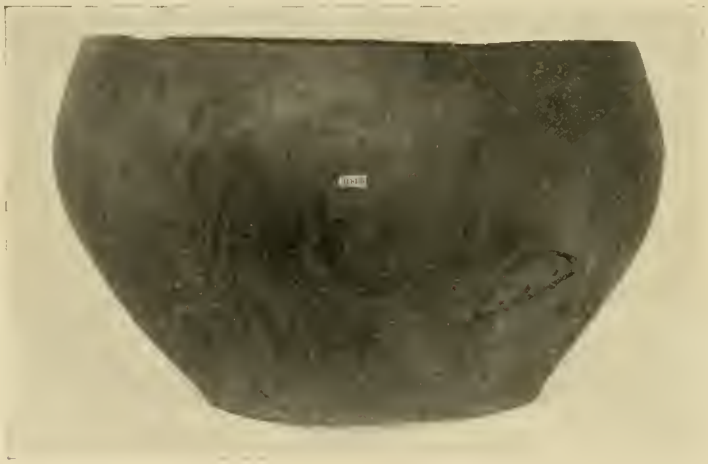


FIG. 144. UMEKE NO. 1049.

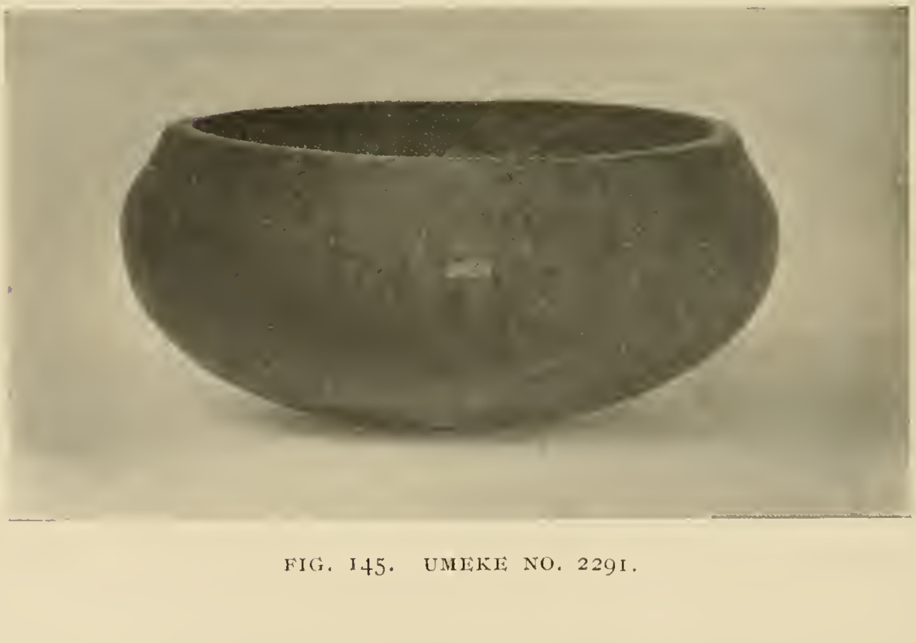


FIG. 145. UMEKE NO. 2291.

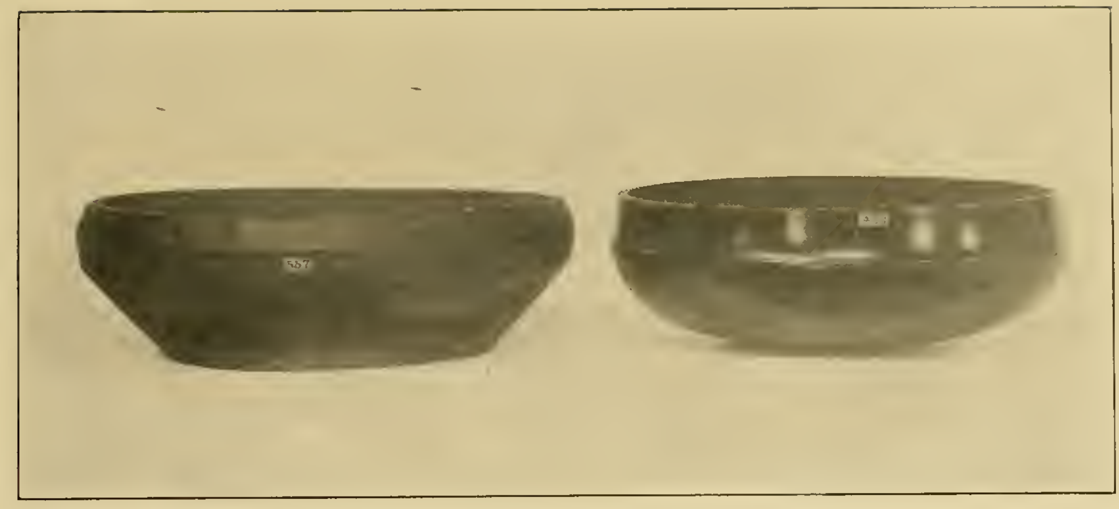


FIG. 146. UMEKE NOS. 557 AND 433.

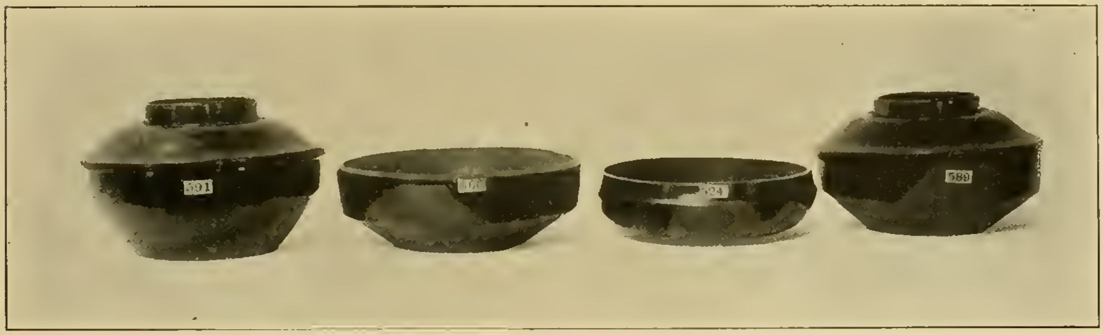


FIG. 147. MODERN TURNED UMEKE.

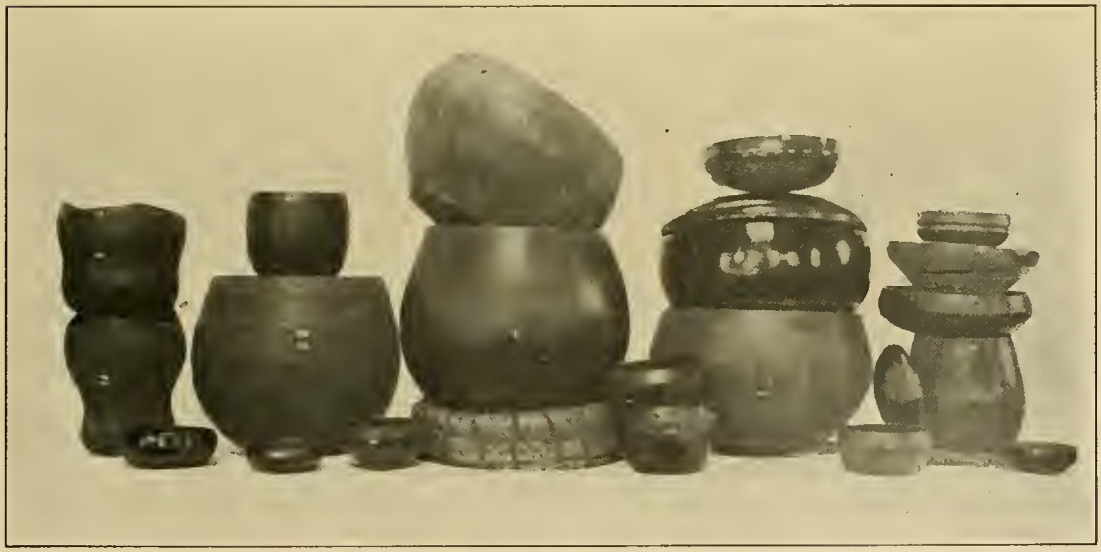


FIG. 148. COMPARATIVE SIZE AND SHAPE OF UMEKE.

bottoms and remarkably thin walls, so that if placed in a horizontal position they at once became upright and oscillated about their centre of gravity.

Anyone who has seen an Hawaiian shape a stone poi pounder with a simple pebble as shown in the first volume of these Memoirs, page 375, and has also noted the considerable variety of working or abrading stones shown in Plates XXXII–XXXV of the same volume, will have less difficulty in understanding how the native worker in wood could shape so truly and excavate so completely the bowls large and small we are now considering. Where we should saw, bore or chisel, he patiently abrades, first with a rough stone, and certain varieties of the Hawaiian cellular basaltic lava had great abrading power, then with stones of smoother grain until both the shape and surface are to his satisfaction. Time is nothing to him; seated in a cool, shady place surrounded by his selected stones and with a huewai of water and an umeke of poi, his workshop was complete. He would busily work until hungry, then a little poi and some water to prevent, as Malo says, its sticking in his throat, and then another pull at his umeke until he is weary and needs a rest, and so varying his occupation the easy going time at last brings an end to his particular work. So little does he like the monotony of any one job that he generally has several on hand, pecking a little

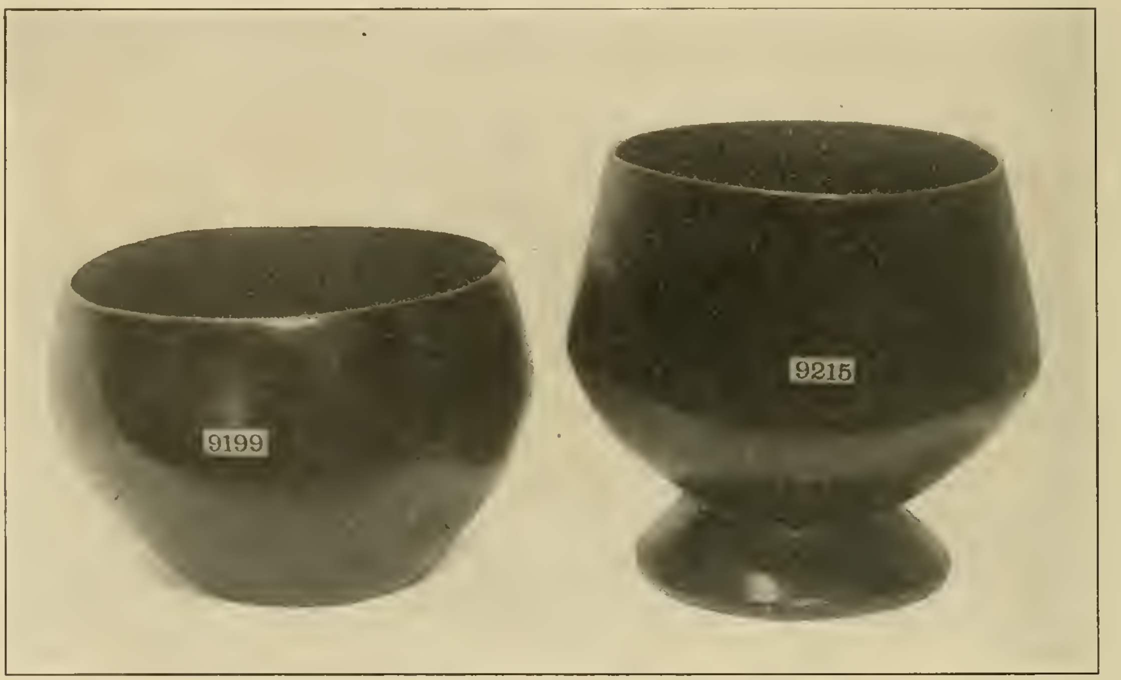


FIG. 149. UMEKE OF KOU: NOS. 9199 AND 9215.

at this and polishing a little on that, that it is really a notable event when he has finished anything. He then goes a fishing, or gives a hula to his friends.

While it is true that the outside is first finished, that does not mean that the polish is complete, but only that the form is determined and a smooth surface that is to be the final one before polishing, for from this the artisan determines the extent to which the interior is to be dug out. The interior was made beautifully smooth for cleanliness in use rather than for appearance, and when this was satisfactory the finer polish of the outside was taken in hand.

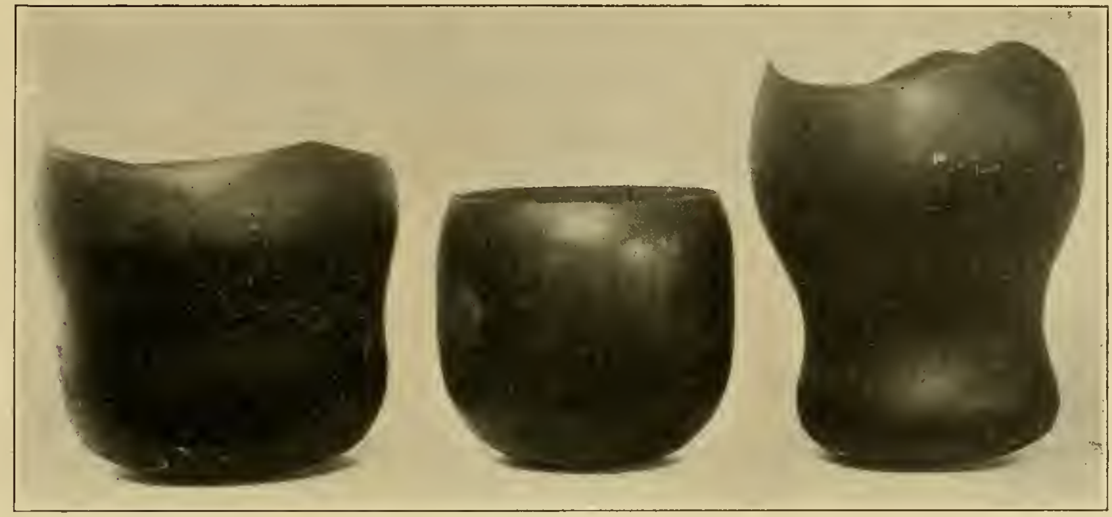


FIG. 150. UMEKE OF UNUSUAL FORM: NOS. 475, 440 AND 1143.

The order has been often stated in which the stones of various kinds were used, but there was no rule in practice that was generally followed: each man had his own way of doing his work and it would vary with the wood he was polishing. Fine coral (*puna*), *pohaku eleku* a rather soft, brittle stone, rough pumice or *ana oahi* (baked pumice), *olai*, *oio* and *lau ulu* or dried breadfruit leaves were all used in about this succession on the finest work, although *welu* of kapa smeared with ochre often followed or took the place of the breadfruit leaves. The patient application of whatever medium was the secret of the beautiful finish of the best of the old umeke.

The ancient hand-made bowls are very uncommon now, although the turner makes tolerable imitations and applies French polish in a way unknown to the old natives, but which suits the taste of modern customers. It is seldom that one sees the fine curves of the old bowls in these modern mechanical imitations, and the makers seem to recognize their shortcomings when they put in patches and make cracks only to fill them again and thus impart a flavor of antique art where the age and art are both wanting.

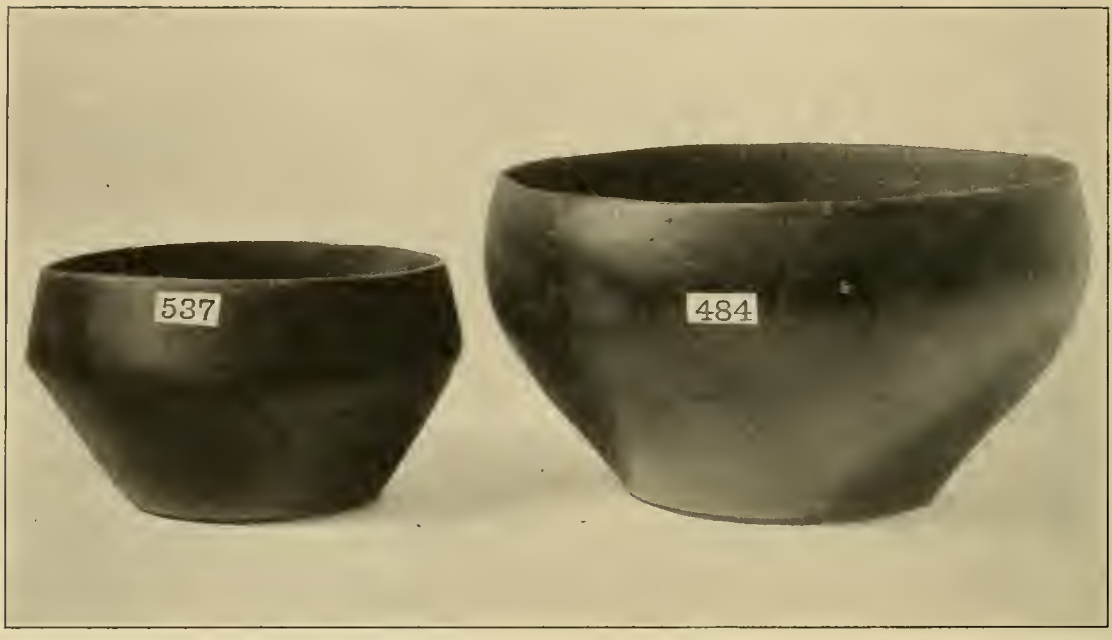


FIG. 151. UMEKE NOS. 537 AND 484.

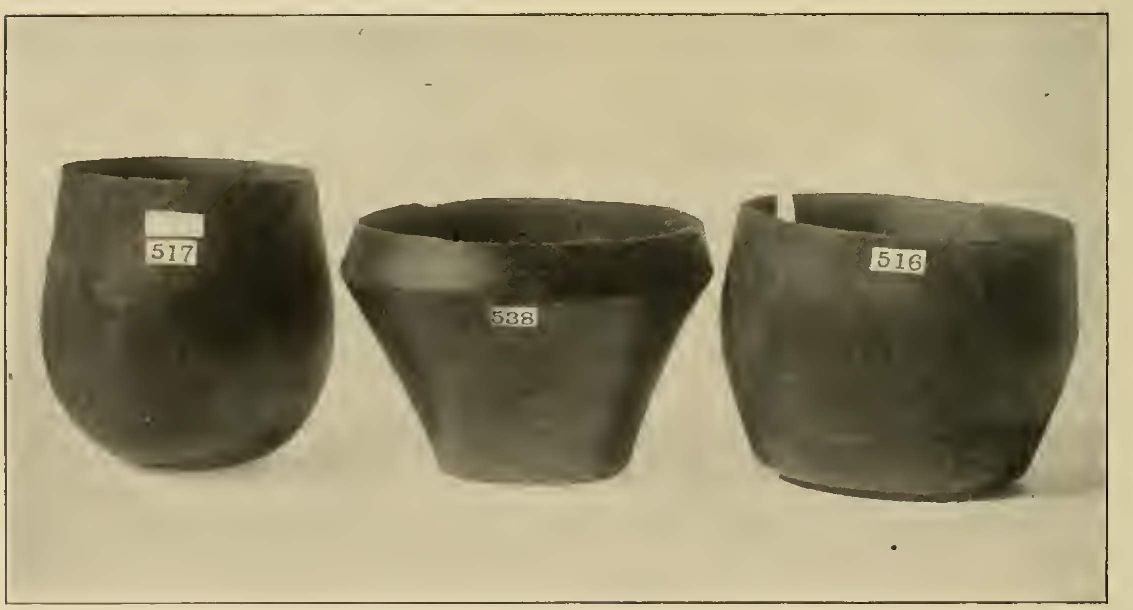


FIG. 152. UMEKE NOS. 517, 538 AND 516.

Only in large collections like those in the Bishop Museum can the choice work of the ancient artisans be studied.

We may glance briefly at some unusual forms of umeke. In Fig. 150 are shown two with the upper edge developed into three angles and a marked constriction in the waist, features that I am unable to explain. That it was not a mere freak of one workman is shown by the number of examples in this Museum apparently not all from the same hand, nor of the same age. They are well made, solid at the base, and have a fine surface.

In Plate XL we have an umeke, not in the Museum collection, with cylindrical sides and a flat bottom, the only one of this shape and size seen. While it seems old, I am inclined to consider it a modern example. The flat bottoms were not peculiar, but often occur in umeke of undoubted age as in Fig. 151, Nos. 537 and 484. Also in Fig. 152, No. 538. A partly cylindrical body but with curved upper and lower edges is seen in No. 481, Fig. 143, and also in No. 440 in Fig. 150. In the umeke with decided external angles, as No. 537, Fig. 151, and 538, Fig. 152, the inside ignores the angle and is evenly curved. In the list given below to show the sizes of the principal umeke in the Bishop Museum it will be seen that many of these, even some of large diameter are comparatively flat, as No. 445.

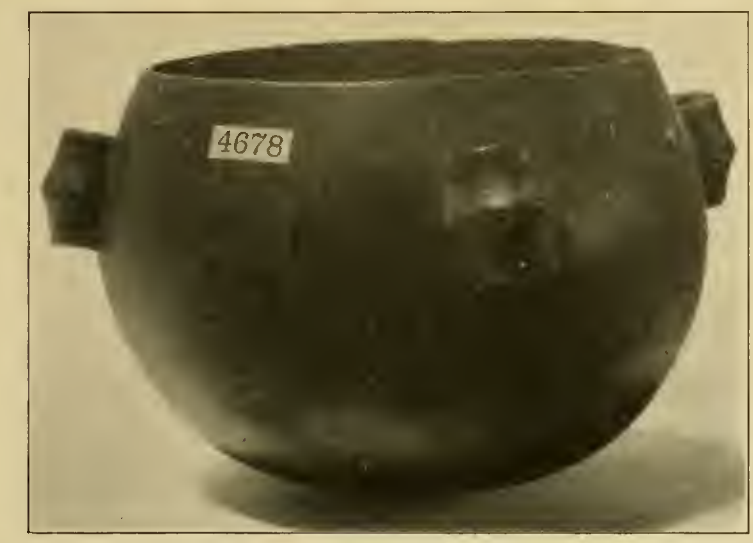


FIG. 153. UMEKE WITH LUGS FOR SUSPENSION.

I have classed with umeke the curious form shown in Fig. 153 which has four lugs remarkably well carved and bored, evidently for the cords by which the bowl was suspended, but why? It was not large enough to hold enough poi for an adult's meal, being only about six inches in diameter. It might have been a vase for the sweet-smelling flowers the Hawaiian loved, to hang from the coconut leaf-covered lanai under which a feast was held, but the inside is clean and not stained as would be probable if used as suggested. My reader must find his own use for this choice little vessel for I am unable to help him farther.

Although all the umeke figured hitherto, except in Fig. 154, have been presented uncovered, a cover was a necessary addition when used as a receptacle for poi, which was attractive to flies as well as natives, and a fly in the poi was as offensive as the proverbial fly in the apothecary's ointment. However dirty the surroundings might be, long, dirty finger nails, grimy hands, and even that rarer thing a dirty bowl into which the dirty hands freely dipped to extract the sticky poi, the most fastidious native could stomach these, but a Fly — we must get another umeke of poi! We have noted that large flat gourds were often, indeed generally used for this purpose, especially among the poorer class, the fine umeke usually had a cover made for them as shown in Fig. 154, and this cover served at a meal for a dish or plate. Often it is difficult to decide whether a round carved flat dish was such or primarily a cover for an umeke. A lot of these round dishes or *pa* are shown in Fig. 155. They cannot be considered distinctively Hawaiian as the form is found all over the world, and there

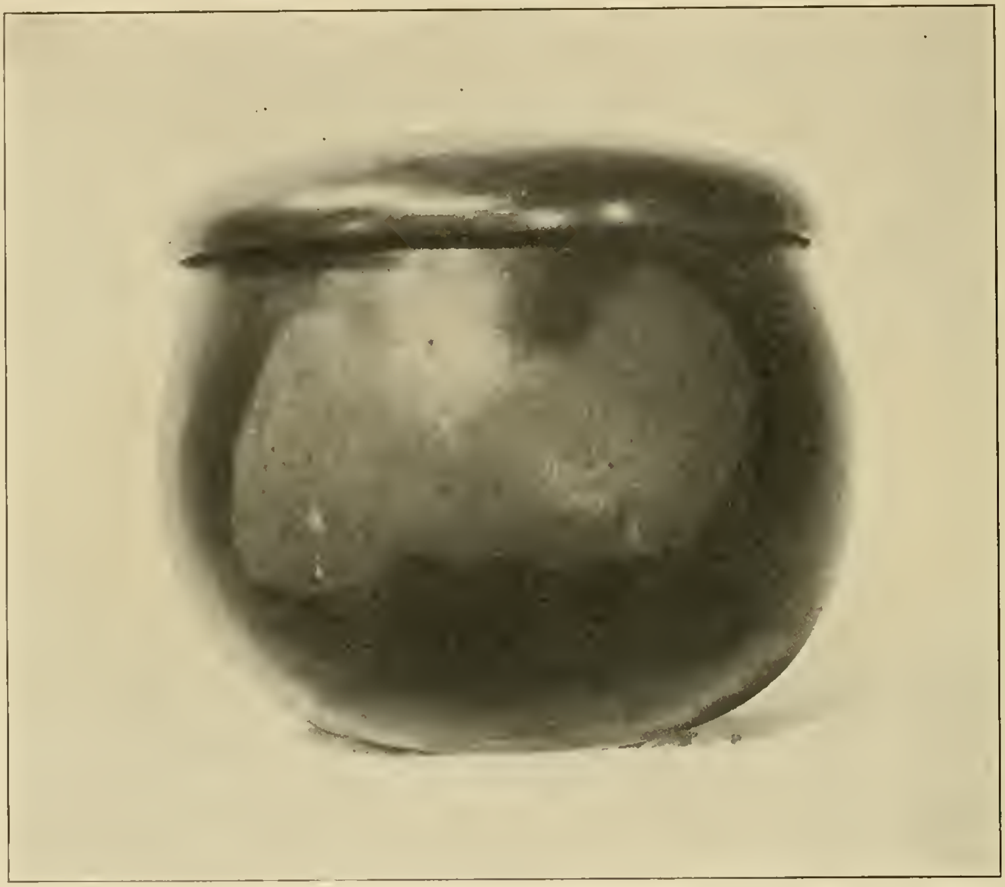


FIG. 154. UMEKE WITH COVER: NO. 420.

is hanging before me, as I write, a mahogany platter or dish that my Carib workman carved for me, entirely without my suggestion, quite like the Hawaiian ones in the figure, except for material. A convenient distinction to be noted in the pa made for covers is the raised edge to hold the cover firmly on the umeke; the smooth plate is constantly liable to slip off.

We have not exhausted the old shapes, for there are containers between the umeke poi and the flat pa, that must be noticed. The lute-shaped bowls shown in Fig. 156 are rare and exceedingly well made. I do not know to what especial use they were devoted. There is one umeke of considerable age in this Museum of the flat-bottom type, but of remarkably fine lines, Plate XL. Another class of umeke has the horizontal surface cut in flat bands: this is curious rather than ornamental, and the effect is shown in Fig. 161. Of the low umeke of great diameter I know of none so beautiful as the one shown in Plate XL. The lines are fine and the workmanship of high order; it was among the treasures of the Kamehameha family; and I wish the name of the unknown artist who designed it could be engraved upon it.

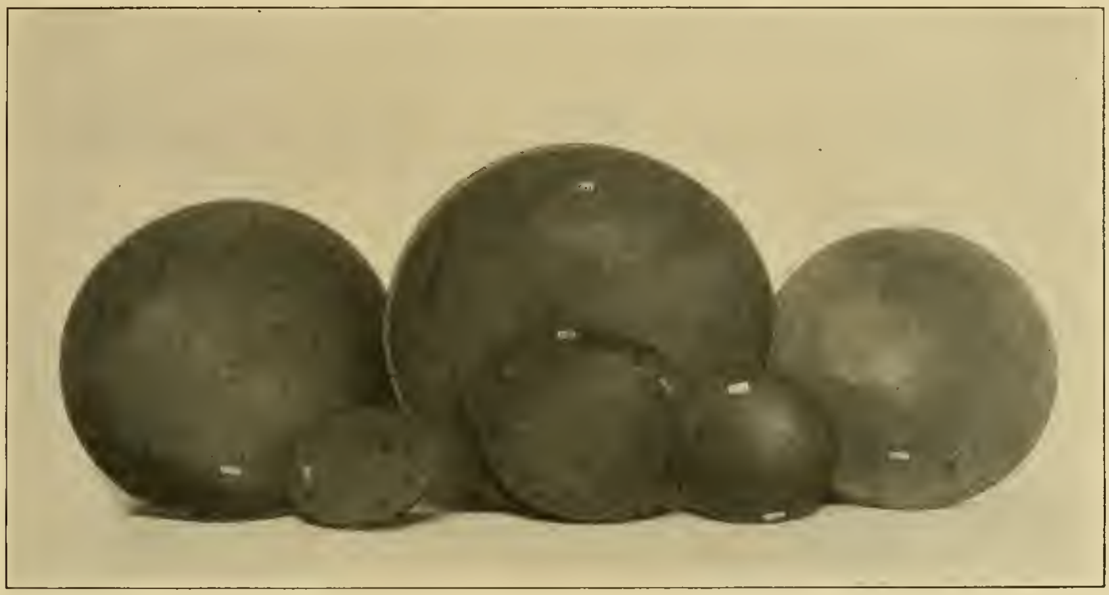


FIG. 155. HAWAIIAN PA OR DISHES.

Where the umeke pass into pa or dishes we have a strange form unlike other Hawaiian dishes both in their general shape, which is elliptical, and in having legs. These are shown in Fig. 157 and their shape is so suggestive of some of the Samoan bowls that I have placed a small Samoan *tanoa* or awa bowl, No. 2150, upon the bottom of the upturned Hawaiian dish. All the latter, however, lack the projecting handle by which the tanoa could be hung up. These large dishes (the largest in the figure is 40.5 inches long) were used for baked pig or dog; some have a depression in the rim, not definite enough to be called a spout, by which the gravy could be poured. Did the Samoan copy the Hawaiian form or was the Hawaiian the imitator? It should be stated that the usual form of the Samoan tanoa was circular, and while they usually had four legs, the number was often greatly increased; one in this Museum having a dozen legs: the polypeds are mostly modern. The Hawaiian awa bowls (*kanoa awa*) were of very simple form, sometimes hardly to be distinguished from the umeke. Two of these are shown in Fig. 158. The dimensions of the bowls with legs (Fig. 157) in the Bishop Museum are as follows:

Museum No.	Diameter.	Height.	Depth Inside.
1213	24.7×17.7 in.	6.6 in.	4 in.
1214	31 ×24.5	8.5	5.3
1215	40.5×20.7	11.5	6.3[76]
1216	32.2×19.6	7.5	5.3

Next may be noticed the unusual form shown in Fig. 161, where the main bowl is divided into four compartments, and there is also an arm carrying a small bowl with only two compartments, perhaps for salt and *inamona* (relish). The main dish reminds one of the vegetable dishes common in the English restaurants made to contain several kinds of vegetable. The old dish at the side has but one shallow cell on the end projection evidently for salt.

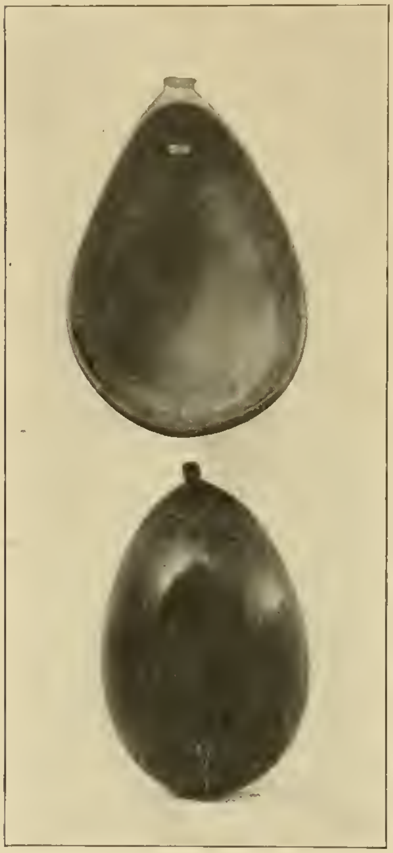


FIG. 156. LUTE-SHAPED BOWLS.

Ipu Holowaa.—Another of the specialized forms of food bowls is that known as the *ipu holowaa* or canoe dish. As we find huewai of genuine ipu in elongated shape convenient to stow away on the Hawaiian canoe (Fig. 120), so the food dishes were sometimes of peculiar shape for the same accommodation. If we add to this the whims of royalty it will be easy to understand the odd forms of umeke shown in Fig. 159. The central umeke, No. 1355, is of fine form and in no way abnormal, but the umeke holowaa on the right, No. 1356, is unlike any other in the Museum, and it is said was used by the great Kamehameha for fish, as the previous one was for poi,

---

[76] Queen Emma collection.

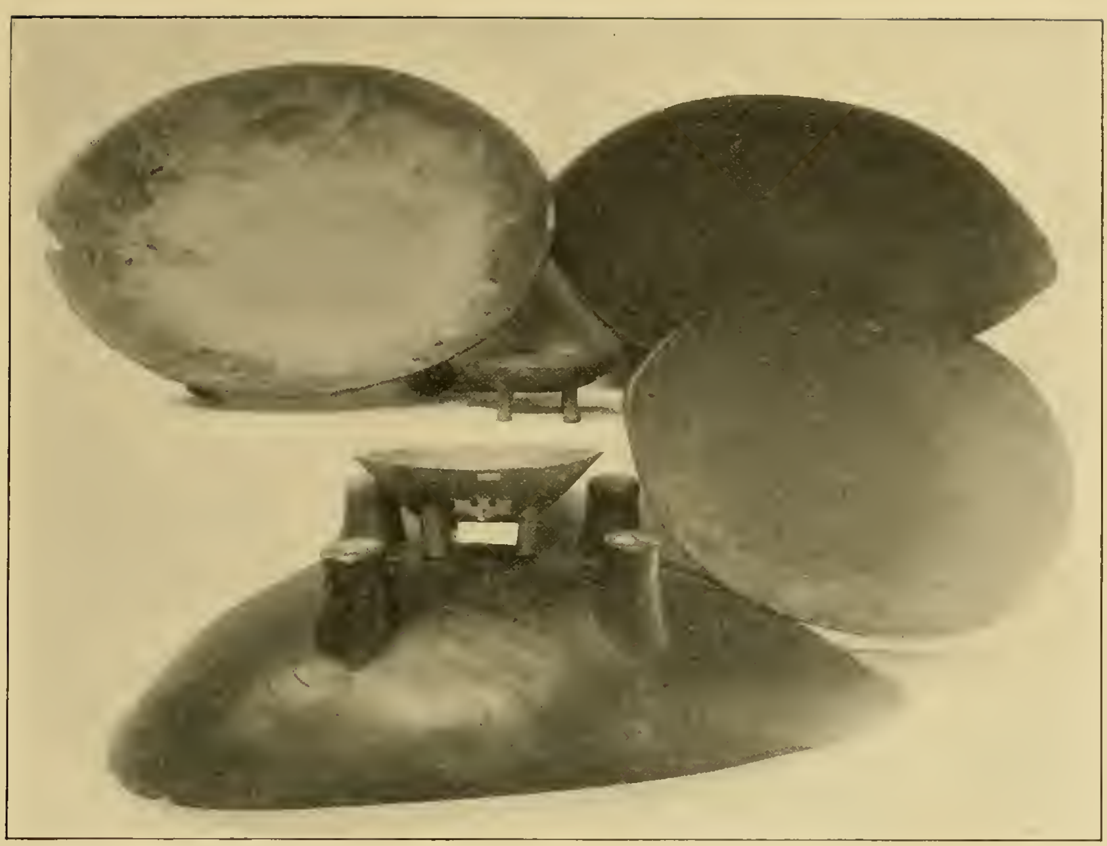


FIG. 157. LARGE HAWAIIAN DISHES.

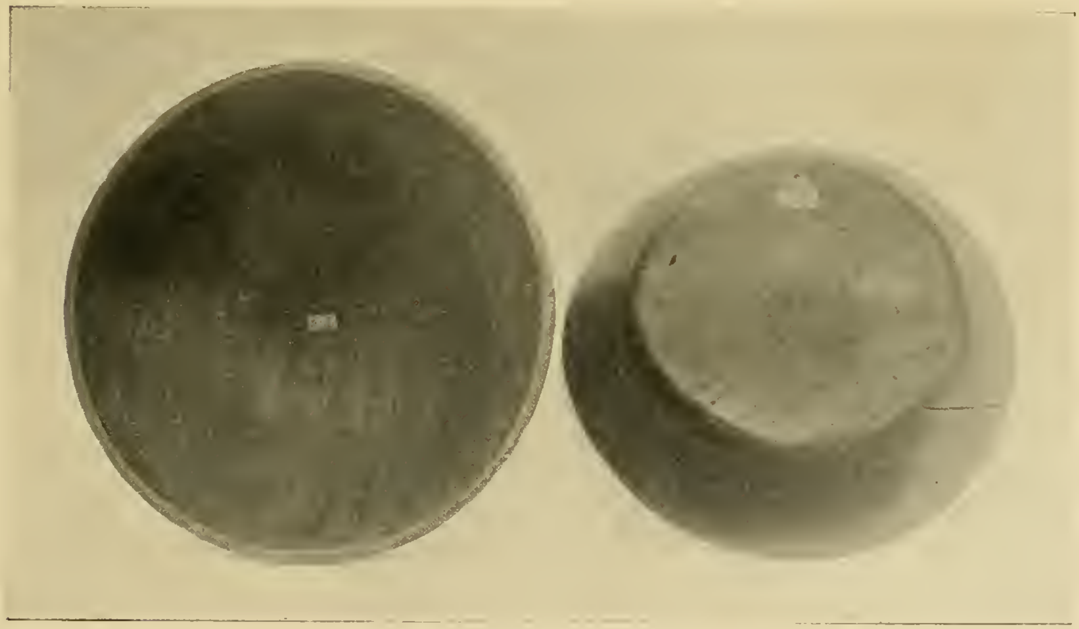


FIG. 158. KANOA AWA: AWA BOWLS.

on his canoe voyages. No. 1357 on the other side, belongs to the set and has a curious formation on the handle which renders its use uncertain. The little spittoon, No. 5009, was also a constant traveling companion of the Conqueror. The other tall umeke (No. 5010) has an even more curious history. It is made of two plates of tortoise-shell (*ea*) fastened together by a narrow strip of the same material in an ingenious and water-tight suture: the bottom is of wood to which the ea is firmly attached. The form of the rim is quite like that of the large wooden umeke in Fig. 144, whose unusual form has greatly puzzled the writer. We know that this was Kamehameha's medicine bowl, and the legend attaches to it that it measured a dose! Even of sweet water it would be a generous one, for it holds a little more than three quarts; but then the king was a mighty man. Does this suggest to us that the other umeke were the utensils of the native *kahuna lapaau* or medicine men, and used in the preparation of their remedies? We know that the old Hawaiians possessed a considerable knowledge of the healing powers of herbs, and that it was by no means their practice to administer insignificant doses. They seemed desirous of filling the patient with their remedy through either end of the alimentary canal.

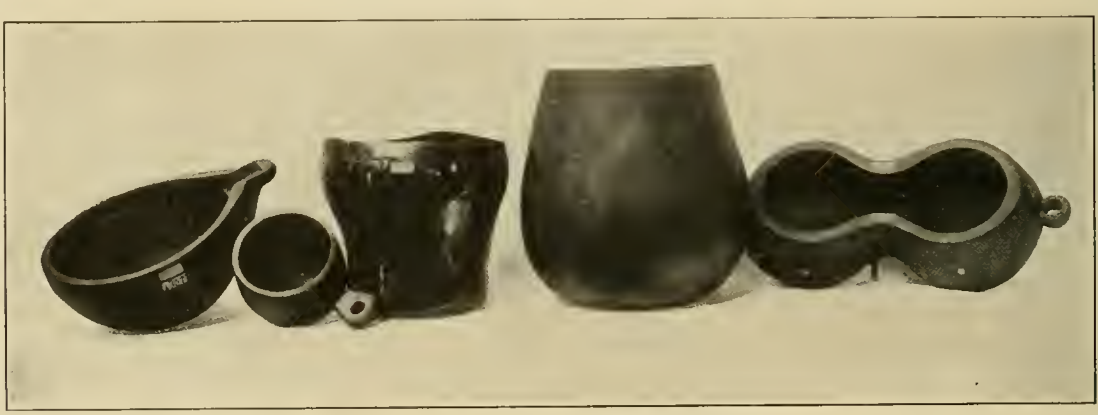


FIG. 159. UMEKE OF KAMEHAMEHA I.

The use of ea in this way may have had connection with the strong superstition that drugs were more virile if treated and used in bone cups or triturated with bone pestles. Ea was also used in Hawaii for small dishes and large combs, and the natives certainly understood the process of softening it by heat to mould it to such shapes as they required. Here should be noted the modern turned umeke shown in Fig. 147 because they are used even now in Hawaiian feasts, and sometimes find their way into collections of Hawaiian umeke as modern imitations of old forms. This they are not, and the covers which are really inverted dishes with a raised rim to serve as handle to cover or base to dish are apparently of Chinese *motif.*

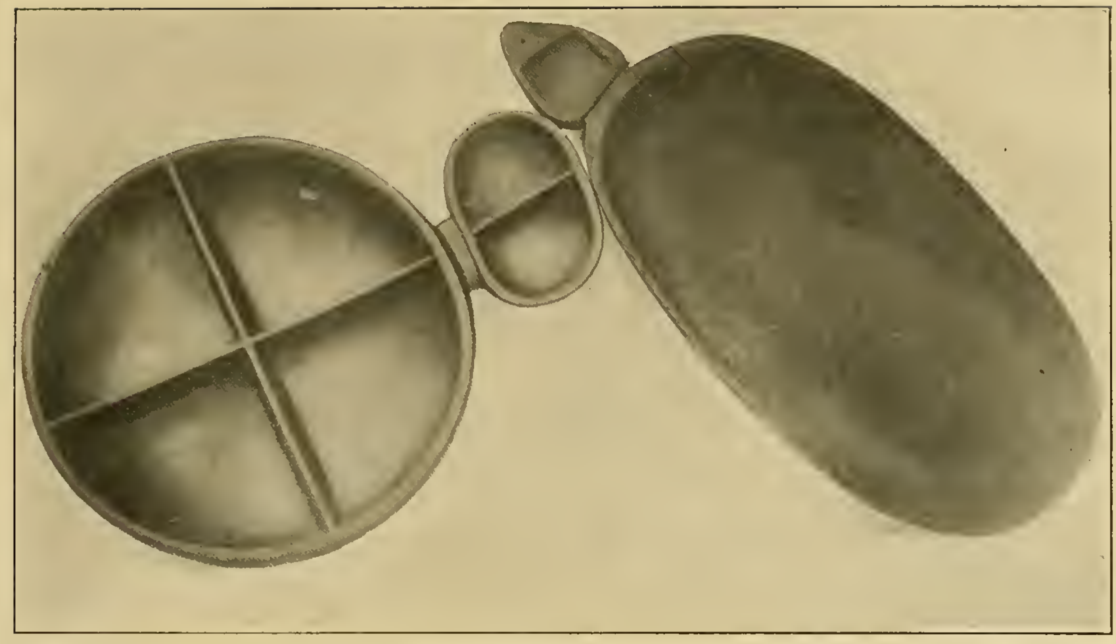


FIG. 160. DISHES WITH COMPARTMENTS.

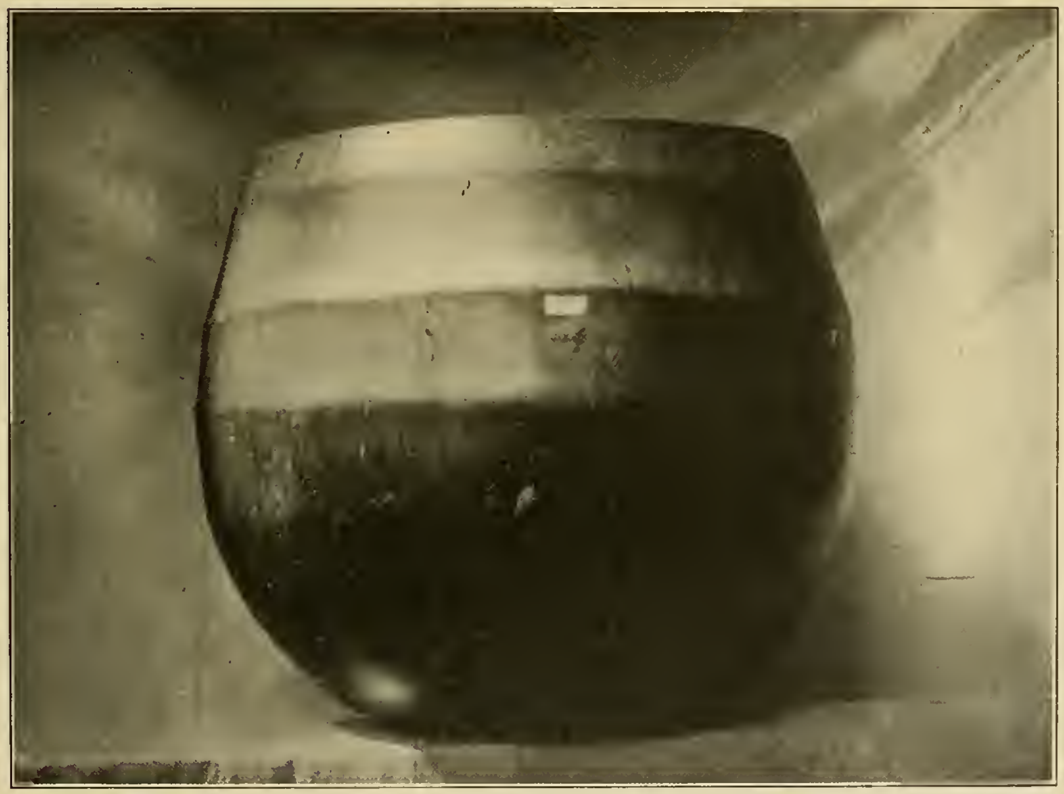


FIG. 161. UMEKE NO. 1050.

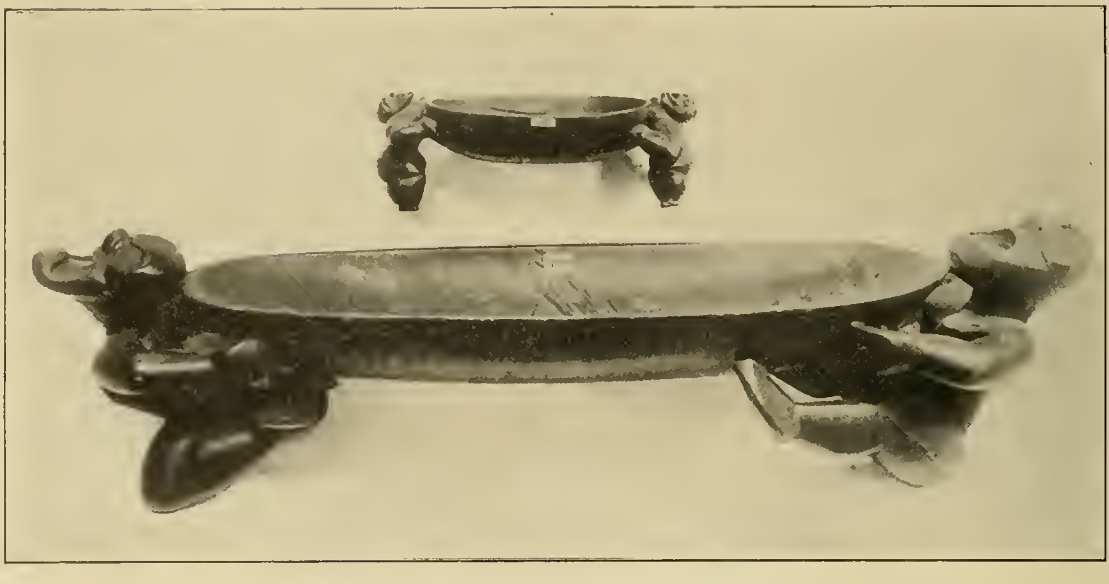


FIG. 162. CARVED HAWAIIAN DISHES.

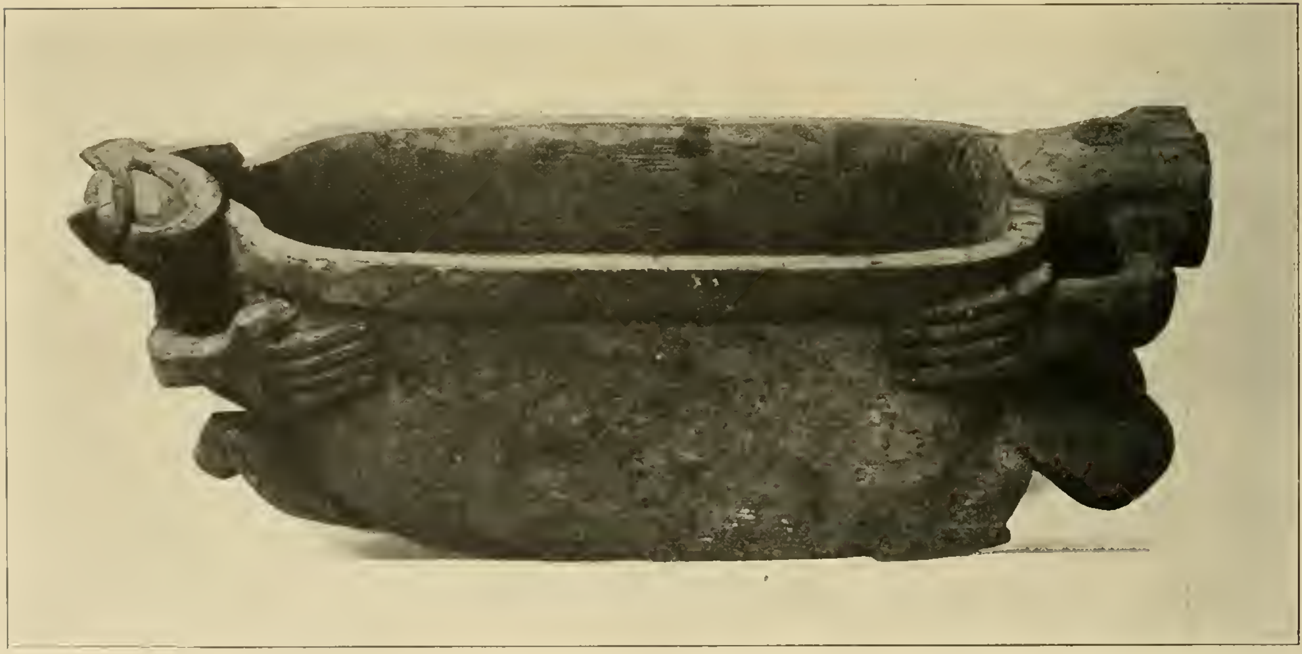


FIG. 163. MAORI DISH USED FOR CRUSHING HINAI BERRIES.

Here should come the carved dishes, once the pride of the alii, but now scattered through the museums of the world. Few indeed remain in their original home. Two are in this Museum and are shown in Fig. 162. The small one, a sauce or gravy dish, belonged to King Lunalilo, and was used during his reign as a card receiver. The other also belonged to the Kamehameha family and was the property of Princess Keelikolani. This is of sufficient size for roast dog or pig. The figures are Kahahana and Kekuapoi his wife, who, it will be noticed both face in the same direction. The mouth of each is greatly exaggerated to form convenient salt cellars. Now while bowls with human supporters are by no means rare (there are several from New Zealand with figures which might, by courtesy to the figures, be called human, in this Museum) they in most cases both face in towards the bowl, or both face out. Here the figures are facing in the same direction and some skill is shown in disposing of the legs of the leading figure. Now among the Maori articles here is a dish or trough, Fig. 163, No. 1532, where the same arrangement obtains: the leading figure here has the head of a monster through whose open gullet and mouth the liquid contents of the dish

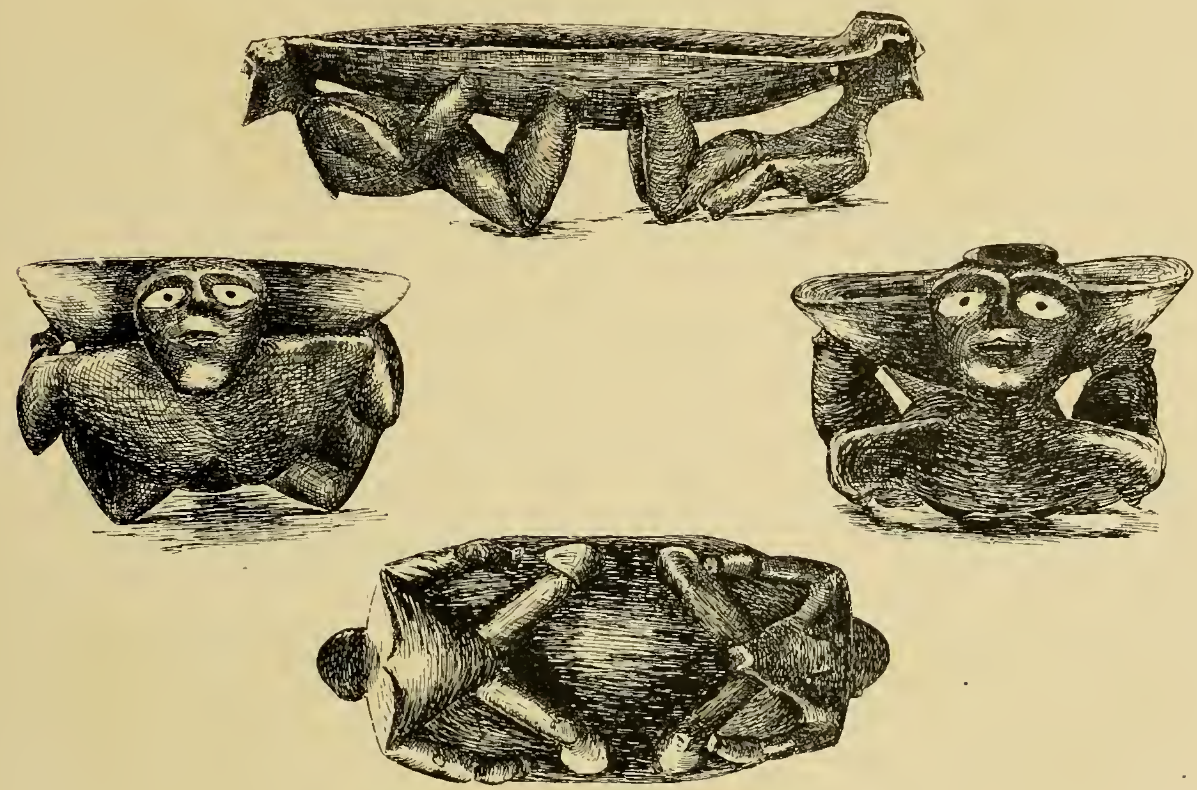


FIG. 164. HAWAIIAN CARVED DISH IN LEIDEN MUSEUM.

can be discharged: the other figure has a human head, certainly of the blockhead type. The Maori dish is rudely carved as may be seen in the illustration, and is not very old, while the Hawaiian example is of great antiquity. Plate XXXV contains most of the carved Hawaiian dishes in the European museums, and there will be seen another bowl now in the British Museum where the same one direction *motif* is used, although the figures are both standing. In a similar dish in the Leiden Museum both figures are attached to the base of the bowl and face outwards.

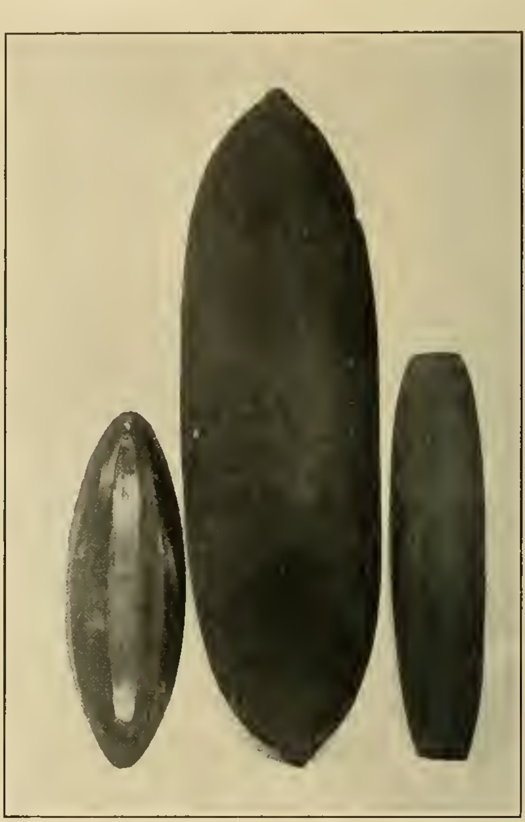


FIG. 165. LONG PLATTERS FROM THE DEVERILL COLLECTION.

The common people had none of these carved or fantastic dishes, but they certainly had a more comfortable substitute for these dishes of the alii. Very many have survived from remote times, buried in the caves where they perhaps held food for the manes of their departed owners. I do not mean to say that the upper classes did not have the very convenient dishes I am about to describe, for they certainly had all worth having that the makaainana possessed, but many of the specimens shown in Fig. 166 are of such rude art that they mark very early time or very humble owners. Some are not very different from the rudely hewn troughs used in both New and old England for feeding sheep, or a better illustration still the log troughs so common in maple sugar camps. Some are square at both ends, others rounded at both ends, and others still, square at one end and rounded at the other. Almost all have some handle or hole fitted with string by which they may be hung up out of the way. They were used for fish or baked meat, and the central one in Fig. 165 is almost long enough for the great eels of the Hawaiian waters: 44.5 inches long and 14 wide.

Before taking up the next articles of house furniture, the finger-bowls, slop basins and spittoons, we will insert a tabular view of the umeke, and allied utensils showing their material and size, and to some extent, their shape, for the Bishop Museum collection is so large, authentic, and varied that it fairly represents the best

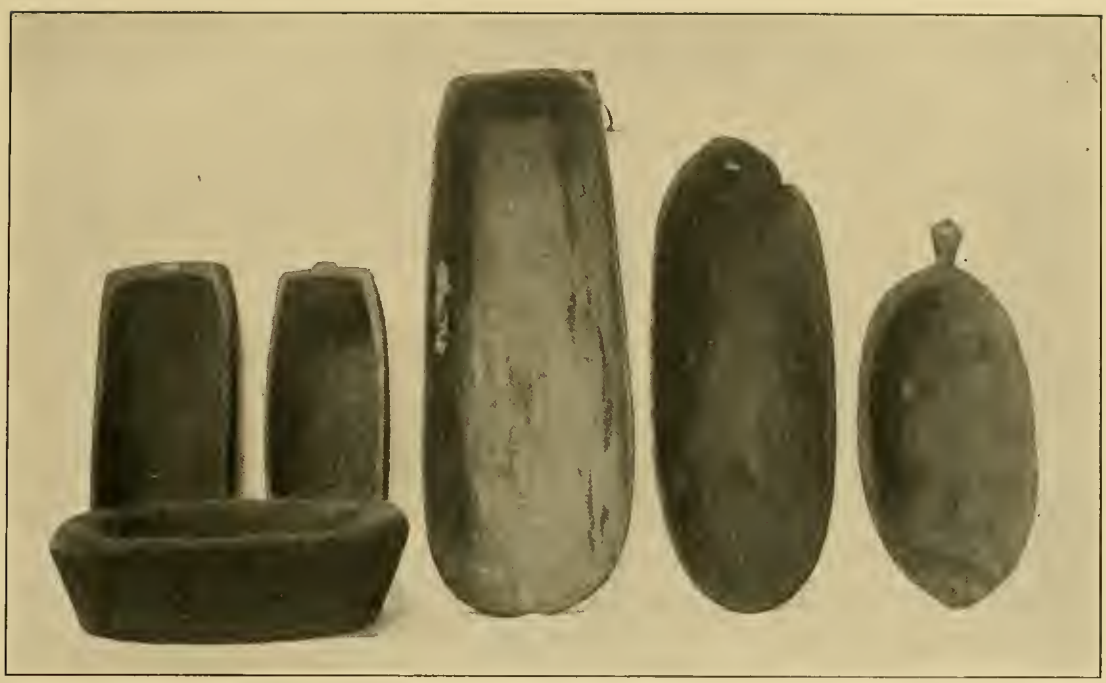


FIG. 166. LONG PLATTERS.

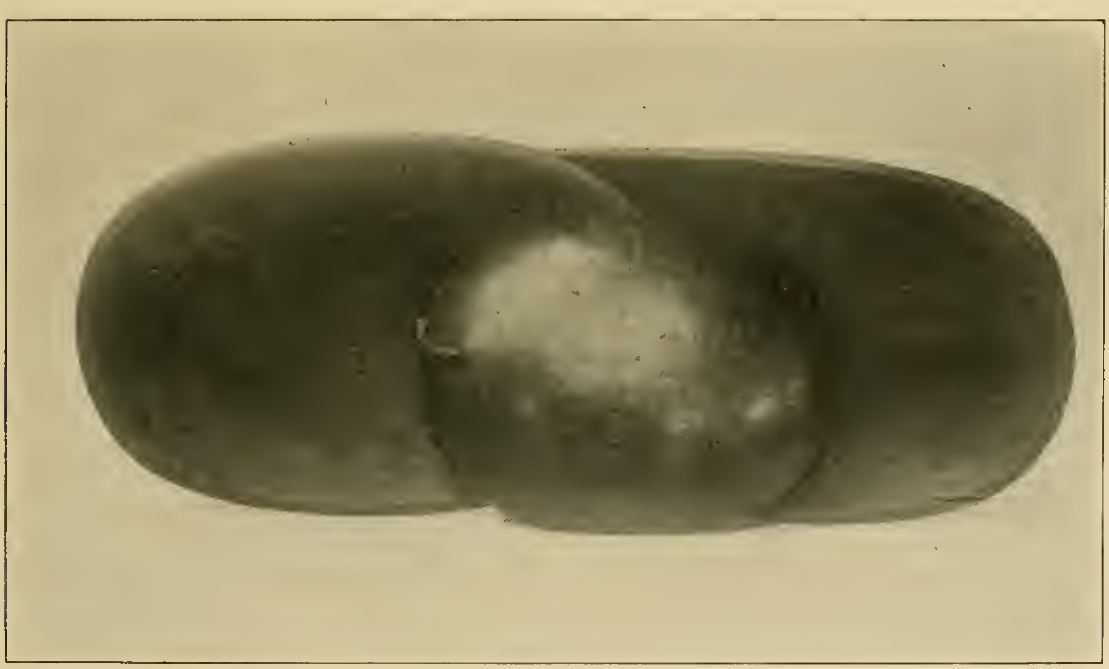


FIG. 167. BROAD PLATTERS.

of such material among the old Hawaiians. I am the more ready to do this because I found that a similar, though far less complete, list given in the first Museum catalogue now long out of print was found useful to a degree not anticipated. The measurements have been taken anew by the Curator of Polynesian Ethnology, Mr. J. F. G. Stokes, whose careful work may be relied upon. The reader not fond of statistics can easily skip the tables.

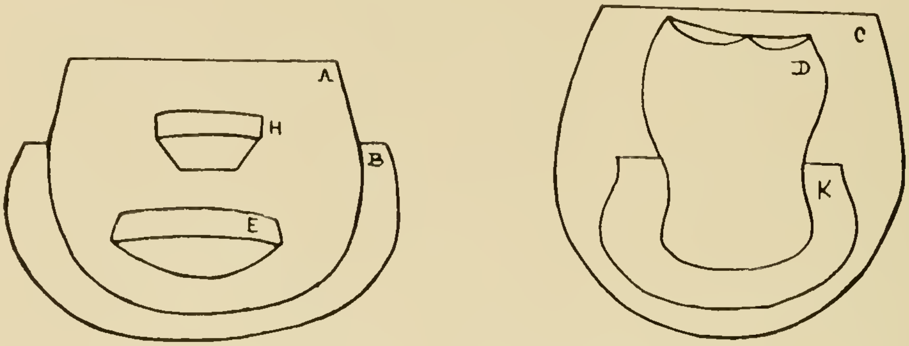


FIG. 168. OUTLINE FORMS OF TYPICAL UMEKE.

In the following table are given first the Museum number, then the material and any notes, the height, diameter and form: the latter designated by letter whose counterpart is given on the outline diagrams of the typical Hawaiian forms, Fig. 168. When the material is not given *kou* is to be understood.

UMEKE IN THE BISHOP MUSEUM.

409	Kou, old.	19.5	29.1	A
410	Queen Emma collection. Fig. 138.	13.3	26.7	B
411	Q. E. Fig. 137.	11.2	26.3	
412		20.3	23.5	A
413		15.1	23.1	A
414	Belonged to Abner Paki	9.5	24	B
415	Kamani, with cover.	10.7	22.6	B
416	Fig. 136.	9.8	22.4	B
417		17.3	22	A
418	Q. E. Flat bottom. Plate XL	6.4	22.1	
419		10.1	21.4	K
420	With cover, Fig. 154	14.3	19.2	A
421		7.5	18.8	K
422	Coconut wood.	11.7	18.7	A
423		11.6	18.4	A
424		6.9	17.2	
425	Q. E. Old.	13.7	17	A
426		12.3	16.8	B
427	With cover.	8.2	16.5	B
428	Turned.	5.2	15.4	K
429		10.8	15.4	A
430		7.8	15.1	B
431		5.9	15	B
432		5.9	14.8	K
433	Turned. Fig. 146.	5	14.5	
434	Q. E.	5.3	14.6	K
435	Old.	6.9	14.3	K
436	Kamani, turned.	4.7	13.4	K
437	Q. E.	12.3	12.9	A

438	Turned.	6	12.9	K
439		7.7	11.8	C
440	Q. E. Old, opaka. Fig. 150	9.7	10.6	
441	Kau, Hawaii.	5.7	15.6	B
442		8	14.8	K
443		6.2	16	E
444		5.8	14.3	K
445	Q. E.	4.3	13.4	E
446	Q. E.	3.7	14.1	E
447	With cover.	4.9	12.9	K
448	Old, unpolished.	6	13.3	K
449	" "	7	12.6	K
450	" "	7.8	18.3	B
451	" "	4.7	11.7	K
452	" "	4.2	11.7	E
453	" "	10	10.9	A
454	Ohia wood, Punaluu, Kau........	8.7	9.6	A
455	Old, unpolished.	4.1	10	K
456	Turned.	4.2	12.2	K
457	"	3.2	11.2	E
458	"	4	11	E
459	"	5	11	B
460	"	4.8	11.1	K
461	Melia azederach.	5	11.9	K
462	Fig. 141.	6.5	10	
463	Eleven-sided.	4.5	9.7	B
464		3.8	9.7	E
465	Plate XXXIX, 4.	6.7	8.7	A
466		3.5	10.5	E
467	Turned.	3	10.8	D
468	"	3.2	9.7	B
469	Old, decahedral. Fig. 143	3.4	9.1	
470	Unpolished.	6.7	9.7	A
471	"	7.3	9.3	A
472	Unfinished.	7.2	9	C
473	Ohia wood. Burial cave............	7	7.6	
474	Kanupa cave.	6.7	8	A
475	Q.E. Old. Fig. 150.	11.7	12.6	D
476	Q. E.	7.6	10.1	A
477	Q. E.	6.6	7.4	A
478		6	7.6	C
479	Plate XXXIX, 1.	5.1	7.1	C
480	" " , 5.	5.9	7.4	C
481	Decahedral. Fig. 143.	5.4	7.9	
482	Plate XXXIX, 3.	7	7.7	D
483	Old, unpolished.	4.9	7.5	B
484	Fig. 151.	4.3	8.1	
485	Kanupa cave.	6.2	7.9	B
486	Old, rough.	6.8	7.1	
487	" "	4.8	11.4	E
488	Hexahedral. Fig. 141	4.3	9.1	
489		4.1	9.3	E
490	With base, turned.	4.2	9.4	E
491		3.3	10.8	E
492		3.3	11	E
493	Rough.	3.8	10.4	B
494		2.7	10.8	E
495	Grooved.	4	9.8	B
496	Turned with base.	4	9.6	E
497		3.7	7.2	A
498	Turned.	3	8	E
499		4	8.1	H
501		4.1	7.7	H
502		4.3	8	K
503		3.4	8.3	K
505	Monkey-pod.	3.3	8.4	K
506		3.1	8.2	K
507		4.2	8.7	H
508	Turned with base.	3.1	8.9	K
509		4.2	6.4	K
510		3.1	7	K
511		2.8	7.5	K
512	Turned.	3.2	6.2	A
513		3.6	6	C
515	Q. E.	3.6	6.1	K
516	Flat bottom. Fig. 152	4.5	5.9	
517	Fig. 152.	5	5.1	
518		3.4	6.2	B

519	Flat bottom.	2.8	6.5	H
520	Turned with base.	3	6.9	B
521	Turned.	2.2	7	K
522	Turned.	2.2	7	E
523	Decahedral. Fig. 141	2.3	7.3	
524	Turned. Fig. 147.	2	7	
525		2.1	7.9	K
526	Turned.	1.6	7	E
527	"	2.4	7.1	E
528	"	2.1	7	K
529	Q. E. Turned.	2.7	7.1	E
530		2.2	6.5	E
531		2.2	5.6	B
532		2.8	5.8	B
533		2.4	5.6	E
534		2.6	5.2	B
535		2.2	5.5	K
536		1.7	5.9	B
537	Fig. 151.	3.2	5.9	H
538	Fig. 152.	4.3	6.4	
539	Q. E. Monkey-pod.	2.7	7.1	B
541	Q. E.	4.2	5	C
542	Burial cave.	5	8	B
543	Kanupa cave.	3.7	8.1	K
544	" "	4.7	9.6	K
545	Burial cave.	4	10	E
546	" "	4.6	9	K
547	" "	4.5	8.7	B
548	Hemispherical.	4.1	9.1	H
549		2.5	7.9	B
550	Hemispherical.	2.7	8.5	B
551	Hemispherical. Burial cave	2.4	9	B
552	Q. E.	4.3	1.6	E
553	Ohia, rough, thick.	3.5	11	
554	Honuapo.	4.2	11.1	
555	Kanoa awa.	4.2	13.3	B
556	" "	4.7	13.7	H
557	" " Fig. 146.	4.8	15.8	
558	" "	5.2	15.3	H
559	" "	4	10	H
560		3	9.5	H
561		3.2	9.8	H
562		2.2	9.2	H
563	Fig. 147.	2.8	9.5	
564		2.6	8.2	H
565	Kamani.	2.9	9.1	H
566	Fig. 147.	2.5	7.6	H
567		2.8	6.9	H
568		2.9	7.2	H
569		2.8	7.2	H
570		3	7.7	H
571		3	7	H
572		2.5	7.2	H
573		2.9	7.1	H
574		2.7	7.1	H
575		2.6	6.1	H
576		2.6	6.2	H
577		2.6	6.2	H
578		2.8	6.3	H
579		2.4	6.3	H
580	Fig. 147.	2.7	6.3	H
581		2.3	6.3	H
582		2.6	7.3	H
583		1.8	7	K
584		2.9	8.2	
585		2.2	9.2	H
586		2.9	7.2	H
587		3	7.2	H
588		3	7.3	H
589	Fig. 147.	2.5	7.1	
590		3	7.1	H
591	Fig. 147.	3	7.3	
592	Goblet shape, like Fig. 139	5.4	4.9	
593	Goblet shape, like Fig. 139	3.5	5.3	
594	Kamani. Goblet shape	7	7	
595	Goblet shape.	6.1	6.7	
596	" "	5.7	6.8	
597	" "	6	7.3	
598	" "	5.3	8.2	

599	Goblet shape.	5	7.4	
600	“ “	4.6	7.5	
601	“ “	4.6	7.2	
602	“ “	4.3	7.5	
603	“ “	4.6	7.3	
604	Monkey-pod. Goblet shape.	4.6	6.2	
605	Monkey-pod. Goblet shape.	4.6	6.1	
606	Monkey-pod.	5	5	
607	“	5	5	
608	“	4.3	5.6	
609	Goblet.	2.2	5.5	
1049	Fig. 144.	14.2	23.8	
1050	Fig. 161.	18.1	21.2	
1051	Nenelaau.	4.4	13.7	
1052	Turned.	4.5	14	H
1053	Kamani.	4	11.2	K
1054		3.8	10.1	B
1055		4.4	10.1	B
1092		8	8.5	
1143	Fig. 150.	14.6	11.8	
1355	Kamehameha I. Fig. 159	9.6	9.4	A
2290		8	17	K
2291	Fig. 145.	8.3	17.8	
2292		7.2	14.8	B
3898	Koaia.	3.2	9.5	E
4004		5.5	7.3	C
4005	Unfinished.	5.2	9.4	B
4006		6.1	12	K
4299		5.1	11.6	E
4678	With four lugs. Fig. 153	4.7	6.5	
4742	Unfinished.	6.7	12.9	B
4743	“	3.2	12.2	E
4744	“	4.4	10.8	
5010	Ea (tortoise shell). Fig. 159	7.2	7	D
5028		3.5	5	A
5595	Unfinished.	3.8	9.4	
5596		5.3	10.2	H
5597		3	12.5	
5599	Koa or ohia.	8	7	
6003	Fig. 139.	6.4	12	
6004	Fig. 139.	6.7	11.4	
6818		3.7	6.7	K
6845		4	8.3	H
7669		5	11.1	E
7868		6.2	12.3	K
7869		6	11.2	B
7870		8.1	14	B
8126	Monkey-pod.	4.7	11.3	E
8127		4.2	10.1	K
8128		5.3	9.8	B
8571	Unfinished.	15.1	18.4	A
8636		7.8	18.8	K
8637		9.3	17	B
8638		9.3	14.9	A
8639		8	12.6	B
8640		7.2	12	B
8641		6.9	14	K
8642		6	14.5	K
8644	Milo.	7.2	10.2	
8645		6.5	10	
8646		4.6	9	K
8647	Milo, turned.	6.2	7.3	
8648	Monkey-pod, turned.	4	7	
8649	“ “	3	7.1	E
8650	Milo, turned.	4.5	4.5	
8651		3.1	6.8	H
8652	Milo.	8.7	13.2	A
8654	Turned.	6.8	8.6	A
8655		4.3	10.5	
8656		4.2	9.8	
8657		3	9	
8658		5.8	12.3	K
8659		5	9.8	B
8660	Monkey-pod, turned.	5.1	11	B
8661		2.3	7.2	H
8662		2.3	7.2	H
8663		5.2	8.7	A
8664	Monkey-pod.	8.6	16.4	K
9192		5.1	8.2	H

9193		3.5	10.4	E	9207		4.7	13.2	E
9194		3	11.8	E	9208		4.5	11.1	B
9195		3.8	8.2	B	9209		8.1	8.9	A
9196		6.3	13.7	K	9210		5	10.5	B
9197		4.5	10.7	H	9211		6.8	14.7	E
9198		2.5	5.7	E	9212		4.9	13.3	E
9199	Fig. 149.	4.4	6.7		9213		6.1	13.3	K
9200		6.1	11.7	B	9214		5	12.1	E
9201		5.2	6.3	H	9215	Fig. 149.	5.8	6.4	
9202		6.1	11.7	B	9216		6	9.2	A
9203		4.2	6.9	B	9530	Plate XXXVIII.	8	20.8	B
9204		8.7	13.1	A	10,081	Hemispherical.	4.3	13.7	
9205		6.1	12.2	K	10,083		9	16	B
9206	Goblet shape.	5	7.5						

Finger Bowls: Ipu Holoi Lima.—An article of elegance doubtless confined to the Hawaiian aristocracy,—the Alii, were the finger bowls so comfortable to the guest at a meal of greasy dog or pig, where fingers were the only forks, and not less where the food was sticky poi. It was usual after eating the meat to dip the fingers into the poi umeke and finish with the *ipu holoi lima*. In many cases the hands were also washed before meals, but this was not the case with the common people, who were, according to the missionaries who first had to suffer from their filth, dirty in the extreme.

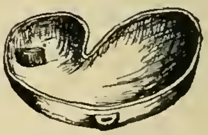


FIG. 169.

These bowls were of most varied forms as may be seen by Fig. 170 and Plate XXX, but may be divided into two general classes: one where the bowl has a single compartment for water; the other where the structure is more complicated and provides not only for water but also for leaves to serve as napkins. Of the latter class, the more uncommon one, are the three bowls in the lower half of the figure. The one at the left has one compartment for water, one for the unused leaves, and another to receive the used leaves; the one on the right has two places for water and two for leaves, while the one in the middle has one bowl for each. All three are each carved from a single piece of wood and are well finished as befits royal use. Many examples of the other and more popular class are seen in the plate and in the upper row of the figure.

One of the most curious is shown in Fig. 169, a sketch of one in the Berlin Museum für Völkerkunde. Almost as *bizarre* are the two in the centre of the plate. In most cases there is in the interior of the bowl a ridge or projection to remove the poi from between the fingers; in one, No. 610 in the Bishop Museum, this projection

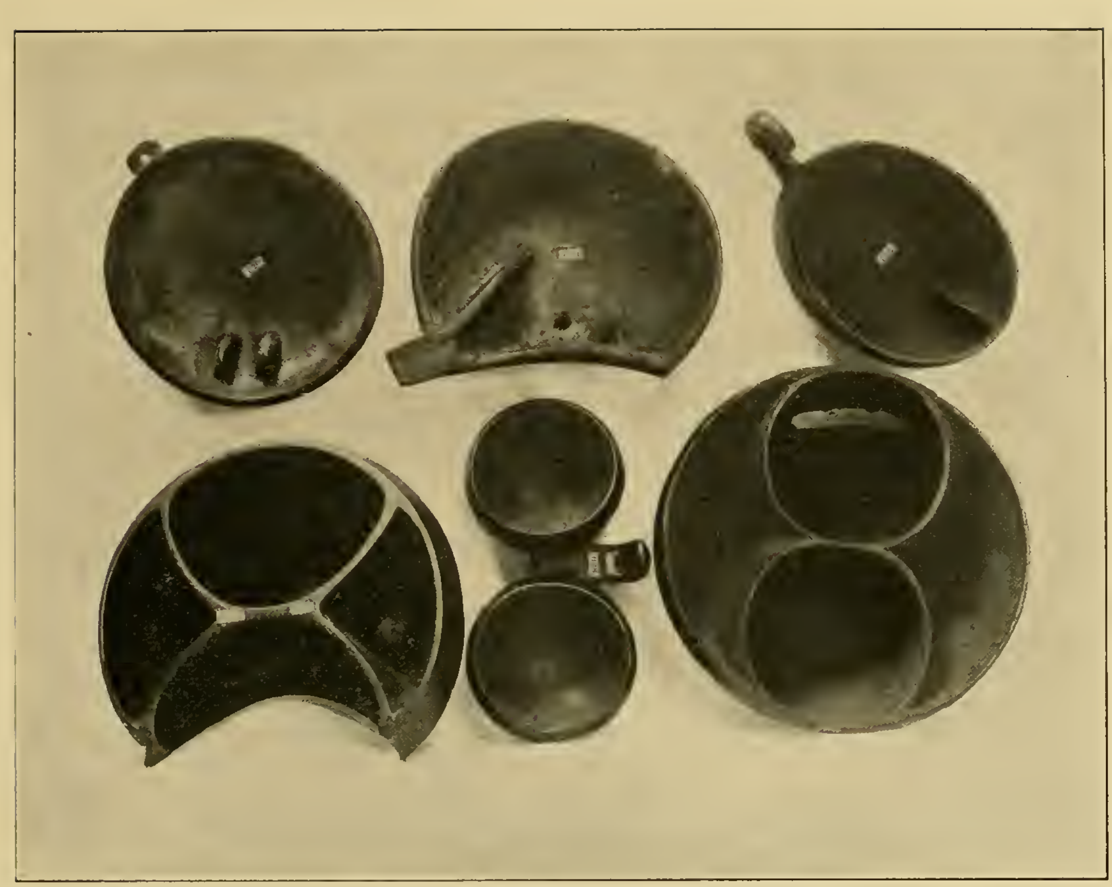


FIG. 170. IPU HOLOI LIMA OR FINGER BOWLS.

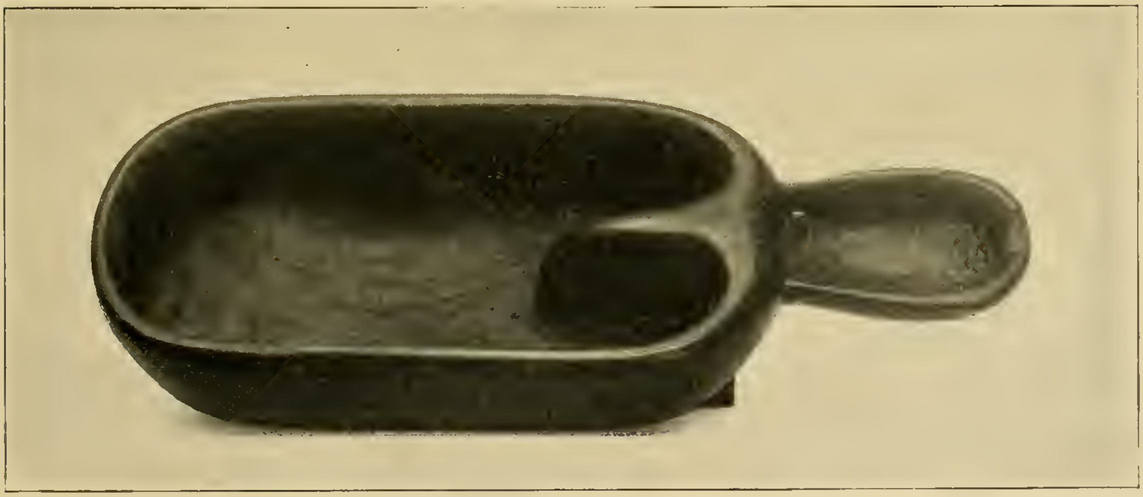


FIG. 171. FINGER BOWL WITH GRIT HOLDER.

is worn to a slender rod by long use (see the upper right hand corner specimen in Plate XXX); in No. 620 of the figure there are two of the ridges, the only specimen we have with this peculiarity. In the collection of the Hon. S. M. Damon, at Moanalua, is a finger bowl with the handle hollowed to hold sand or grit as a substitute for soap, an unique form so far as known (Fig. 171). Certainly the old Hawaiians of the upper class had attained some civilization before the coming of the missionaries!

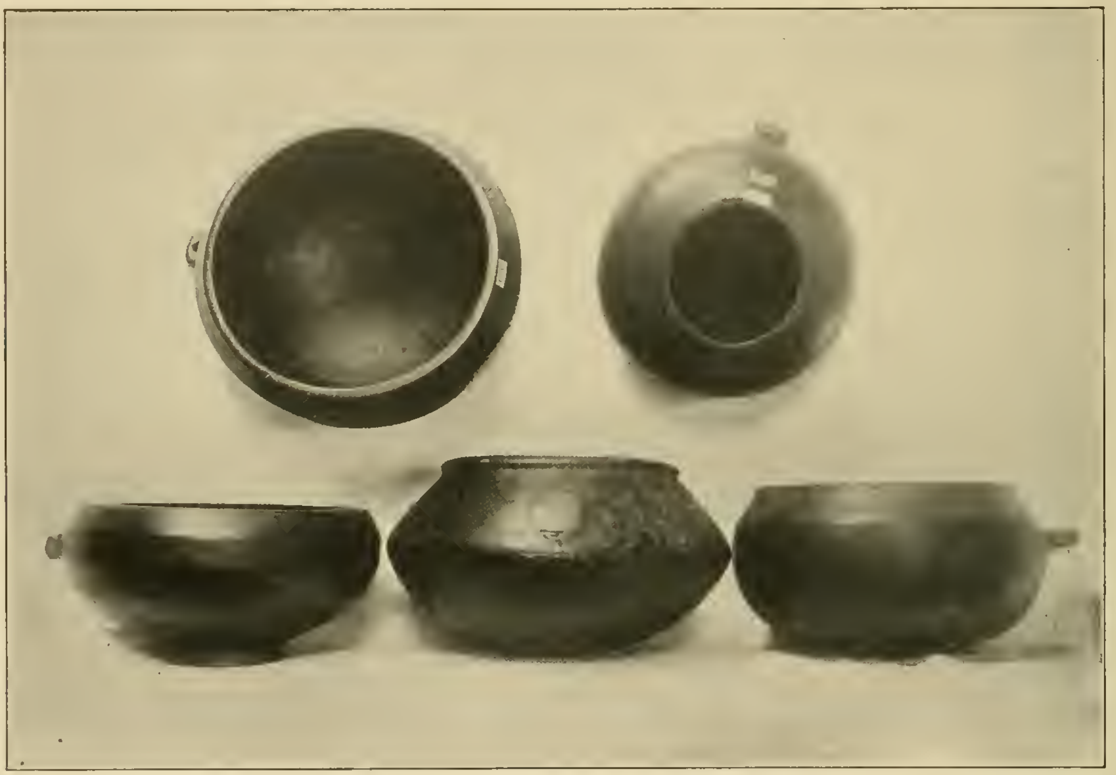


FIG. 172. IPU AINA OR SLOP BASINS.

Na Ipu Aina = Slop Basins.—An article used almost exclusively by the chiefs at their feasts to receive the refuse of their food, as fish-bones, banana skins, etc. They were thick and heavy (No. 638 weighs seven pounds) and not infrequently inlaid with the bones or the teeth of an enemy,—sometimes of many enemies, as in No. 6927 (Plate XXXI), where no less than 289 molar teeth are inserted in a bowl cut from a log of hard pine drifted to these islands from the Columbia River region. In No. 9069 many teeth are inserted and ground to show a cross section; in some of these teeth the exposed nerve cavity was so large as to require a filling, for which a splinter of another tooth was used. In No. 4144 bones were used as well as teeth and very neatly inserted.

This use of human bone for decoration has before been referred to, and it need only be repeated here that while it was deemed honorable to have one's bones in a kahili handle, in umeke, and sacred drums, it was regarded as a gross insult to the dead enemy whose solid parts were attached to spittoons or slop basins, or other "vessels of dishonor". This Museum is fortunate in having a considerable number of these fantastic mementos of perished enemies. See Plate XXXI. In some cases, as No. 9290 in the illustration, the vessel was used in sorcery and then styled *Umeke poe uhane*. The fragment shown in the plate was from the Deverill collection, and the other half is supposed to be in Kohala, Hawaii.

The following list includes also the plain slop basins: they are, with the one exception mentioned, of kou wood:

		Diameter.	Height.
630	This plain bowl is possibly an ipu holoi lima	12.5	5.5
634	Keelikolani collection, narrow base	11.5	5.7
635	Old and mended long ago	13.2	7.7
636	From Queen Emma's collection	10	5
637	Hawaiian Government; one tooth and an empty socket	9.2	4.2
639	Queen Emma collection	12.5	7
6927	Pine from Northwest Coast; weighs 7 lbs	12	6
4144	Bones and teeth; Queen Emma collection	9	4.5
9069	Cave on Hawaii; 63 teeth	10.1	5.6
9290	Deverill collection; fragment of umeke poe uhane	11.5	7

Ipu Kuha: Spittoons.—Not an agreeable adjunct to the house furniture, and yet, so far as it went, a sanitary measure that was not often found among uncivilized people. Among the Hawaiians there was a deep-rooted belief (and three generations of Christian civilization have not much weakened the belief) that the kahunas or priests had a power over the lives of men which was brought into action by the *pule anaana* or praying to death, and that not by the mere length of the prayer. This power was not confined to the priests in later days, and others might possess this sort of "evil eye", but in all cases to exercise it a portion of the intended victim must be prayed over by the sorcerer. I do not care to go into this most interesting subject here, for I shall treat it at length in another work, but in short there were persons well known to have this power in greater or less degree, and they were quite ready to exercise it for pay. The person desiring the death of an enemy secured a lock of his hair, the parings of his finger nails or his spittle: the last perhaps most easy to obtain under ordinary circumstances without exciting suspicion: hence the existence of ipu kuha. The higher the position of a man the more enemies he was likely to have, and the spittoon bearer of a chief was his most trusted attendant who received and guarded the contributions of the day, and at night washed the receptacle in the ocean if possible, if not, he carefully buried the accumulated saliva.

I have seen these ipu kuha brought into church a generation ago, and they are common enough in museums. All sorts of odd forms were chosen and the handle is often unsymmetrically placed, but is always an integral part of the block of wood from which the cup was carved. Plate XXXII shows the more important examples in the Bishop Museum. The commoners did not take such pains, as they had fewer enemies and less means to secure the services of a strong kahuna, one "powerful in prayer", and to the present day they are by no means so careful as they should be where they spit. We have no spittoons from other groups, nor do I know of their existence outside the Hawaiian group, among the Polynesians.

With Plate XXXII the following list of the principal ipu kuha and the allied ipu mimi in this Museum will give some idea of their shape and size:

IPU KUHA IN THE BISHOP MUSEUM.

		Diameter.
678		8.5
679		8.5
680	Mug shape, ring handle.	7
681		6.7
682		7.5
683	Mug shape, ring handle.	7
684	Broad, flat edge.	8
685	Ring handle.	8.7
686	Very broad edge, hook handle.	8.5
687	" " " " "	7.2
688	Broad edge, hook handle.	8.2
689	" " " "	8
690	Flat handle.	6.5
691		6.2
692	Flat handle.	6
693	Hook handle.	6.5
694	Sharp edge, impractical handle	7
695	Mug shape, hook handle.	6
696	Mug shape, flat handle.	5.2
697	Cup with hook handle.	6
698	Mug shape, hook handle.	5.5
699		4.7
700	Mug shape, flat handle.	4.5
701	Oval, Queen Emma coll.	5×4.6
702	Ribbon handle.	5
703	Oval, ring handle.	7.5×5.7
704	Oval, ring handle.	7.2×4
705	Square, ring handle.	5.5
706	Square, hook handle, Q. E.	5
707	Very old, ring handle.	5.5
708	Burial cave, ring handle.	6.2
709	" " " "	6.7
3999	Mug shape, hook handle, old.	7
4000	" " burial cave.	5.5
4001	Govt. coll., broken handle.	5
4002		7.7
7515	Hook handle.	7.5
7564	Mug, flat handle.	5
7684	Mug, hook handle.	5.7
8089	Hook handle.	6.2
4003	Oval.	9.5×7.5
4143	Convex bottom, with 17 teeth and 1 socket	6.3
9222	Deverill coll., hook handle.	6.7
5009	Kamehameha's private, flat handle	4.3

Ipu Mimi.—When the spittoon was of larger size, but of the same general form as the ipu kuha it received the discharges from the distal end of the alimentary canal or from the bladder, and being made of so porous a substance as wood, it was important to cleanse it thoroughly and to expose it to the full sunlight: this custom has been faithfully continued with the crockery successor to the wooden ipu mimi, as may be noticed by the traveler at almost any native house in the country. Specimens of these vessels are shown in Plate XXXII, at the bottom. Fortunately most of these necessary but unpleasant containers were destroyed on the advent of the cheaper foreign crockery pots, and specimens are rarely if ever found in museums.

I do not believe this to have been an ancient implement, nor was it used by the common people, who were very careless about the natural excretions of the body: their *hale kiona*=privy, I do not believe existed before the contact with white men, and the term was probably made up to use in the translation of the Scriptures. *Kio* means excrement and *kiona* the fundament.[77]

IPU MIMI IN THE BISHOP MUSEUM.

		Diameter.	Height.			Diameter.	Height.
675	Kou, hook handle.	12	3.5	3997	Ring handle.	9.2	6
676	Hook handle.	9.5	3.5	3998	Hook handle.	8	3.7
677	" "	10	3.5	3999	Broken handle.	7	4
678	Ring handle.	8.7	4	3214	Hook handle.	9.5	2.6
679	" "	8.5	5				

Mirrors.—I have elsewhere[78] described the Hawaiian stone mirrors (*kilo pohaku*) as one of the most ingenious of savage contrivances. Malo mentions also a wooden mirror, but I have never seen one nor do I know of any that have survived in museums. With the importation of the far more efficient coated-glass mirror these native reflectors soon vanished; the wooden ones utterly, while those of stone were used as a cooling application to furunculi or other inflamed portions of the body,—they became *pohaku lapaau* in the *armamentarium chirugicum* of the Hawaiian kahuna lapaau or medicine man, and then usually had a small hole drilled near the outer edge for a suspending cord. These mirrors of stone disks, and doubtless the wooden ones likewise, had no reflecting surface when dry, and were not used, as Malo states, by merely wetting the surface, but were wholly immersed in a shallow dish of water, when, as may be seen by the experiment, a fair reflection appears when the stone is in shadow and the face well lighted.

---

[77] In the early sixties I heard in the Haili church at Hilo a capital sermon in Hawaiian the text being from Deut. 23, 13. It was brought home to the simple Hawaiians by the suggestion "Consider poor pussy", and from my observations at that time, I do not doubt the congregation needed the practical sermon of the excellent missionary.

[78] Stone Implements and Stone Work of the Ancient Hawaiians. Memoirs of the Museum, vol. i, p. 398.

We have specimens (Fig. 173) of the native mounting of the foreign mirrors that Vancouver (and perhaps Cook) brought to these islands. Mere strips of looking-glass framed neatly enough in wood with a handle carved on one of the long sides of the frame. In the British Museum is a curious example of these frames, shown in the sketch (Fig. 174). On the bottom of the frame are carved two miniature tobacco pipes, while on the upper side is a tube nearly a third of the length, through which a cord was passed. The larger one in the Bishop Museum (Fig. 173) was given to Kamehameha by Vancouver and has doubtless reflected the faces of all the Hawaiian courtiers of that stirring era which witnessed the culmination of Hawaiian character. All these frames were carved in one piece; the glass was cemented in by a rather poor putty of red ochre. Very small specimens were attached to the handkerchiefs (equally foreign) of the female Alii, a parallel to the former French fashion of inserting a tiny mirror in eventails. It is not likely that this adaptation of the foreign looking-glass extended beyond the few examples used by the high chiefs, for after Vancouver's visit commerce soon brought the cheap and more convenient forms. The ancient indigenous forms must always have remained a luxury for the wealthy Hawaiians, and specimens are rare in museums.

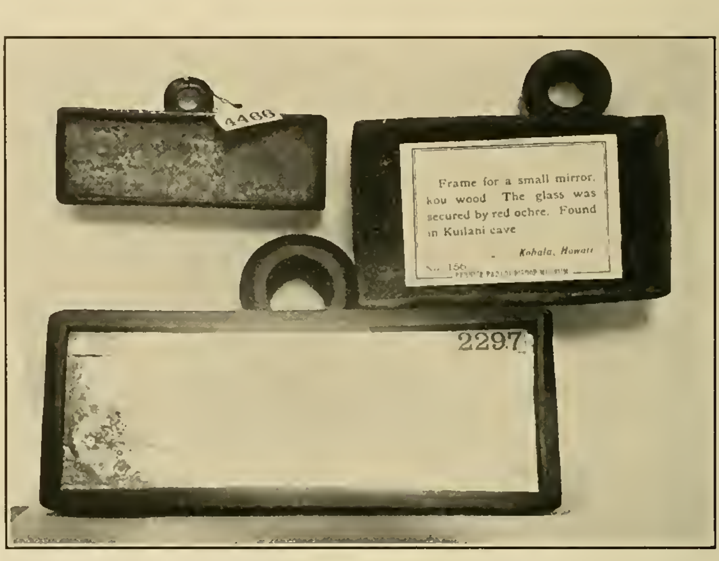


FIG. 173. HAWAIIAN MIRRORS, END OF EIGHTEENTH CENTURY

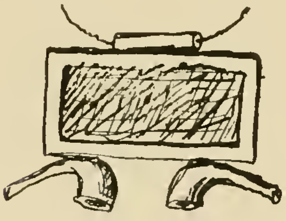


FIG. 174. HAWAIIAN MIRROR IN BRITISH MUSEUM.

Only those who have moved from a house in which they have long resided can appreciate the many little conveniences that accumulate and have been forgotten in our complicated and artificial life. To a less degree, of course, but none the less surely there will be found many forgotten things necessary to the simple life of the old Hawaiian, but which are never collected and so do not appear in museums. If we could have the sweepings of the old Hawaiian houses, so to speak, the things thrown away by their owners as unfashionable or superseded by some better invention, we should gain footnotes that would perhaps be worth more than all the text! The things that turn up in kitchen middens were refuse once but now are oracles of history, truer, if carefully read, than most that is called history.

Idle is it to lament over things we may have lost, when we shall doubtless omit to mention some of the things known to others as well as to ourselves but forgotten in the gathering of the household utensils old and new, that should find place in an old Hawaiian house of the better sort. Even when we plead guilty of passing by the stone implements, the feather-work treasures, the baskets and mats, on the plea that we have told all we know about them before, and again speak slightly about tools for kapa making which were most important things about the house; about the weapons that from the earliest times must have been the title deeds to the ownership of the house itself; of the games of which the implements were not only in the house but often so dear to the residents that they were placed together with the choicest possessions in the burial cave where the bones of the departed were hidden: because all these things are so important in themselves that they must be treated more fully by themselves than they properly could as mere furniture to a house. Whatever excuse may be brought forward, there are other things that come under none of these heads and should in any liberal plan be described with other furniture, but which may be forgotten, that it behooves us to search carefully for what may have been overlooked.

Fibres played so large a part in the economy of Hawaiian life that doubtless in most houses we should find the scrapers shown in Fig. 175, those on the left made of the pearly and hard shell of a bivalve (*Uhi kahiolona papaua*), and the rest, the far more common ones, made from the bones of the carapace of the large turtle common in these waters (*Uhi kahiolona kuahonu*). These were used not only to clean the fibres of the oloná, but also to remove the outer bark in kapa making, and even as the *strigil* of the ancients to scrape the human body. Used in so many ways they were doubtless common in and about the houses. With the scrapers went the *Laau hahi olona*, a strip of wood six to eight feet long and three to five inches wide, with one surface slightly convex and smooth. Like the scrapers these laau were used for other fibre than oloná, as waoke, mamaki, etc., so there was generally one of these stuck in the thatch somewhere about the house. The method of using is shown in Plate XV of this volume, representing a native scraping oloná for spinning net cord.

While a fisherman would doubtless have many of the implements of his calling in and about his house, such as fishing sticks, traps, nets, hooks, etc., many of the Alii were also fishermen (*e. g.*, the Kamehameha family) and kept their choicer implements in their dwellings, especially *ipu le'i* (Fig. 176), a container of fish hooks or hooks and line also; the smaller part was an umeke of wood and the cover, much larger, of gourd: some choice ones were all of gourd and of small size. The common fishing line container was a bottle gourd with a large neck capped with a small coconut shell. (Plate XXXIII.) In these the fine oloná lines were so carefully kept that it is no wonder that one would last several generations of fishermen.

The Alii had their canoes which were kept in the halau or canoe-house, but the paddles were often a part of the house furniture, not infrequently forming decorative devices with the spears which belonged to every chief. The common people often made an old canoe a part of the house itself in placing it close to the side towards the wind, the inner gunwale just under the thatch so that the drip of the rain would flow in.[79] It must be noted that some of the inland villages were apparently poorly supplied with water, as the houses on the slopes above Mahukona, Hawaii, and we know that in some cases the people brought water from springs far up the mountain. Portlock and Dixon when anchored off Waikiki in 1786 watered their ships by carriers with gourd containers filled at the upper streams (Manoa, Makiki). Captain Dixon says:

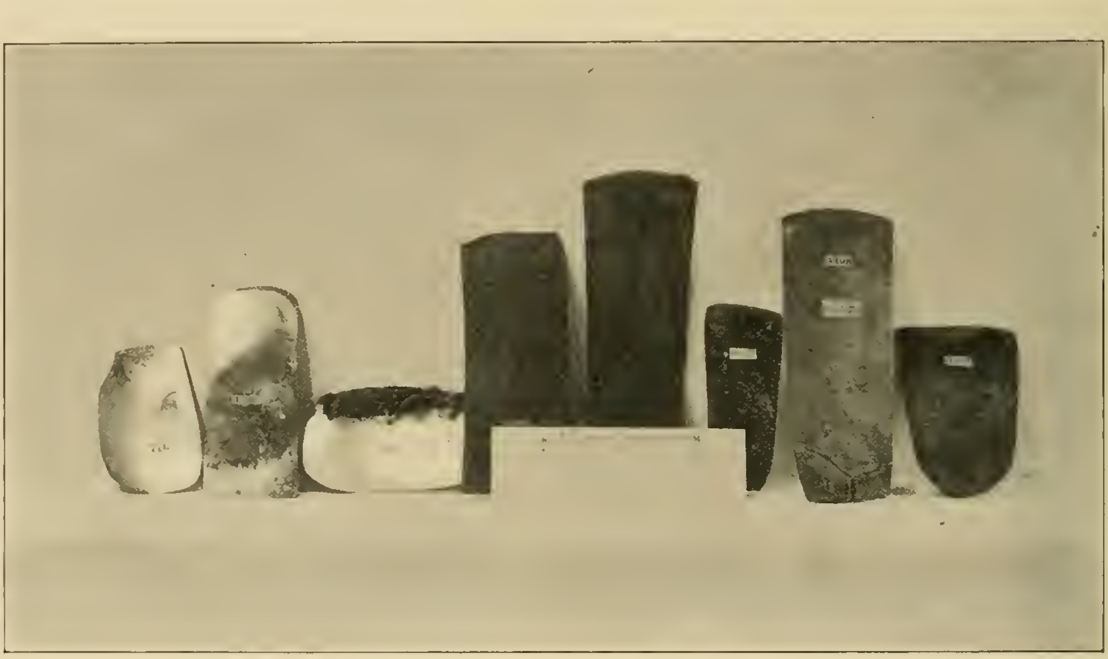


FIG. 175 UHI KAHIOLONA: SCRAPERS.

> Early in the morning of the 2d [June, 1786] our Captains went on shore in order to find a watering place, and procure accommodations for the sick: they soon met with good water, but the access to it was very difficult, occasioned by a reef of rocks which run almost the length of the bay,

---

[79] To within a few years there existed at the side of the little bath-house over a steam crack near the Volcano House at Kilauea an old canoe used to catch the drip from the roof during the frequent rains. It had before that served to collect rain water at some one of the native houses formerly in the vicinity of the crater.

at a considerable distance from the shore, and so high that it was scarcely practicable, and by no means safe for a loaded boat to venture over: this circumstance made us despair of filling our water at this island; but Captain Dixon taking notice that most of the people in the canoes had several gourds or calabashes full of water, he directed us to purchase them, which we easily did for nails, buttons and such like trifles: indeed so fond were they of this traffic, that every other object was totally abandoned, and the whole Island, at least that part of it which lay next us, were employed in bringing water: for a small or a middling sized calabash, containing two or three gallons, we gave a small nail; and for larger ones in proportion. Thus in this very singular, and I may venture to say, unprecidented manner, were both ships compleatly supplied with water, not only at a trivial expence, but also saving our boats, casks, and tackling, and preserving the people from wet, and the danger of catching cold.[80]

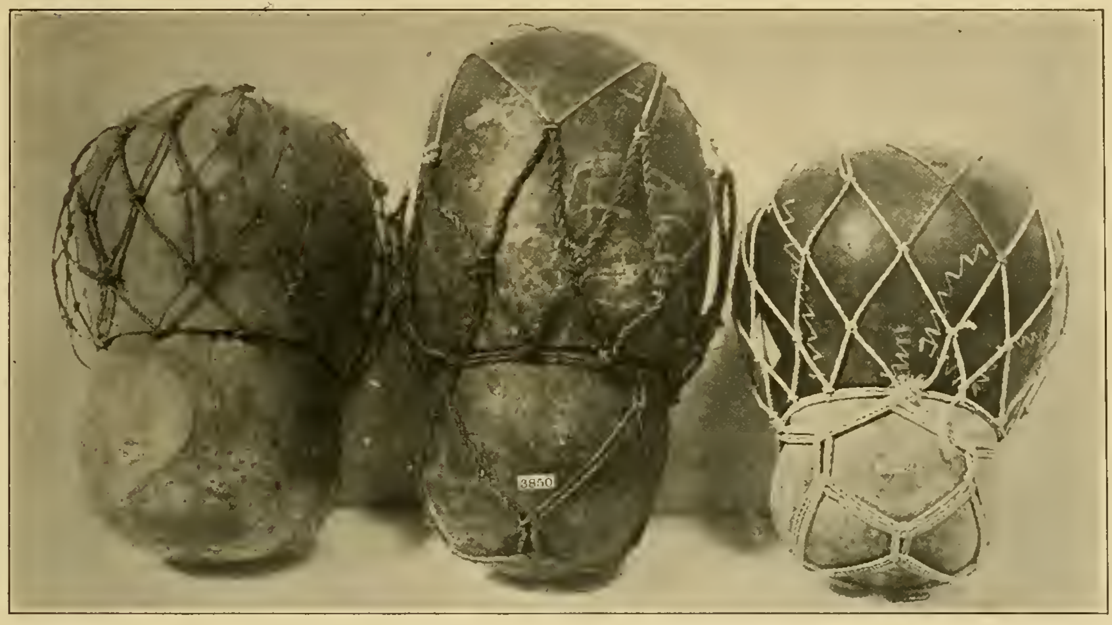


FIG. 176. IPU LE'I FOR FISH HOOKS AND LINES.

In Puna, where springs are scarce and streams unknown, large ipu are placed in lava caves to catch the drip through the porous lava roof. This was common practice all through the lava region and many a thirsty traveler has quenched his thirst at such reservoirs.

Rats and mice troubled the ancient as they do modern dwellers on these islands. Menzies and his party from Vancouver's ships, who ascended Hualalai on Hawaii, were greatly annoyed by these rodents in the hut where they passed a night in the mountain region. To reduce the number the Hawaiian used a small bow and very light arrow, such as shown in Fig. 177. How early they invented the bow and arrow we do not know, but they do not seem to have made great use of this weapon in war.

---

[80] A Voyage round the World; but more particularly to the North-west coast of America; performed in 1785, 1786, 1787, and 1788 in the King George and Queen Charlotte, Captains Portlock and Dixon. By Captain George Dixon. London, 1789. p. 52.

Probably its use was confined to "rats and mice and such small deer", but it was probably to be found in most respectable houses.

Kahili = Brooms.—Another necessary thing in every house, whether the hut of the makaainana or the large house of the Alii, was a *kahili* or broom, which is also shown in the same figure. This was in no way like the splendid ornament of feathers which bears the same name and has been described and figured in the first volume of these Memoirs, but was simple in the extreme, and its simplicity doubtless suggested its use wherever the coco palm grows. A handful of the dried midribs of the leaflets of the coco palm leaf, either held loosely or tied together at the base (as was most common in Micronesia), made a practical broom convenient enough when the user could squat as the Pacific islanders do, the kahili being held almost horizontally. An old woman sweeping a garden path in this way always attracted the attention of a stranger. The remaining object in the figure is a small wooden hook to be fastened to the aho within the house: on this the koko holding umeke or huewai could be suspended, or indeed anything else hung up out of the way.

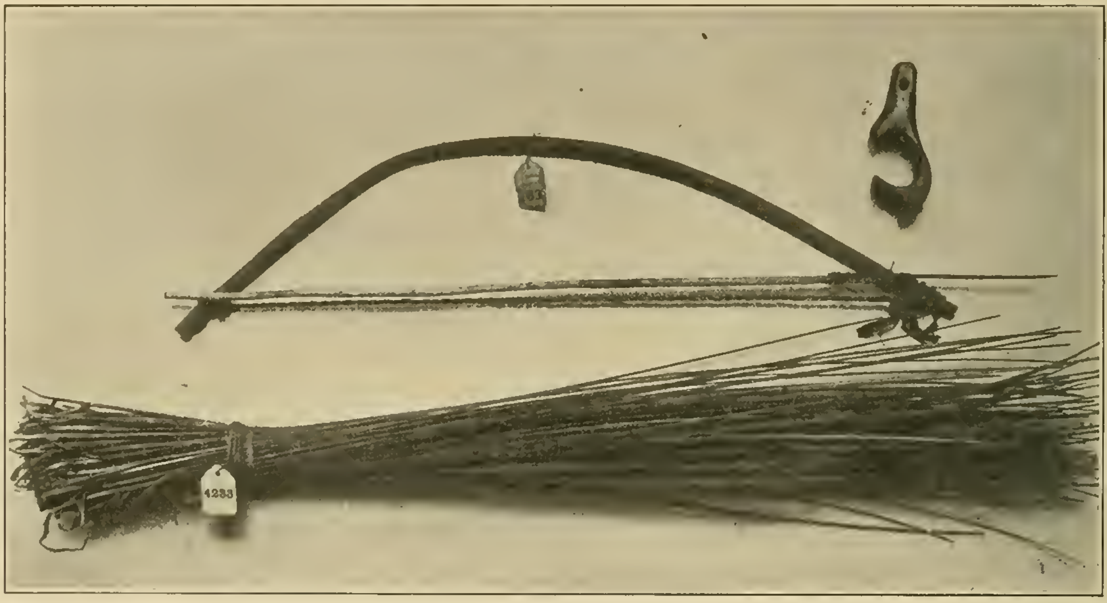


FIG. 177. HAWAIIAN BOW AND ARROW AND BROOM.

Noho or Stool.—Although the Hawaiians used neither stools nor chairs for resting but preferred the matted floor where they could recline at ease,[81] the chiefs on occasions of ceremony sat on low stools. These were carved from a single block (*monoxylon*) and were perhaps borrowed from Tahiti or other southern islands whither the adventurous Hawaiians are known to have sailed in ancient times. One of these Hawaiian stools is shown in Fig. 8 (which is repeated here for convenience of reference). It is on the right, a well cut but unornamented block of ohia wood; heavy and solid, it resembles a Samoan tanoa unexcavated. It is 18.7×17.2 inches on top and 9 inches high. On the left of the figure is an ancient stool once the property of a chief of Anaa in the Paumotu Archipelago; on the top of the first is a stool from the Marquesas used by the copra graters as indicated by the projection (which is an integral part of the stool), armed with a piece of rough coral for grating. Many of the European and American museums have Tahitian stools of light and graceful form, but the pattern is in all cases the same, and all are, I believe, monoxylon. The Hawaiian stools are very rare and the present specimen (B. M. 4345) is the only one I have seen. A more fantastic stool is in the British Museum; it represents a female figure, not unlike those figured in the second Memoir of this volume: she is on all fours, the head raised and the legs trailing. This is shown on Plate XXXV (D).

---

[81] I have seen an aged Hawaiian woman, evidently very uncomfortable on her pew seat at church, gradually slide down to the floor where her satisfied look proclaimed her greater comfort.

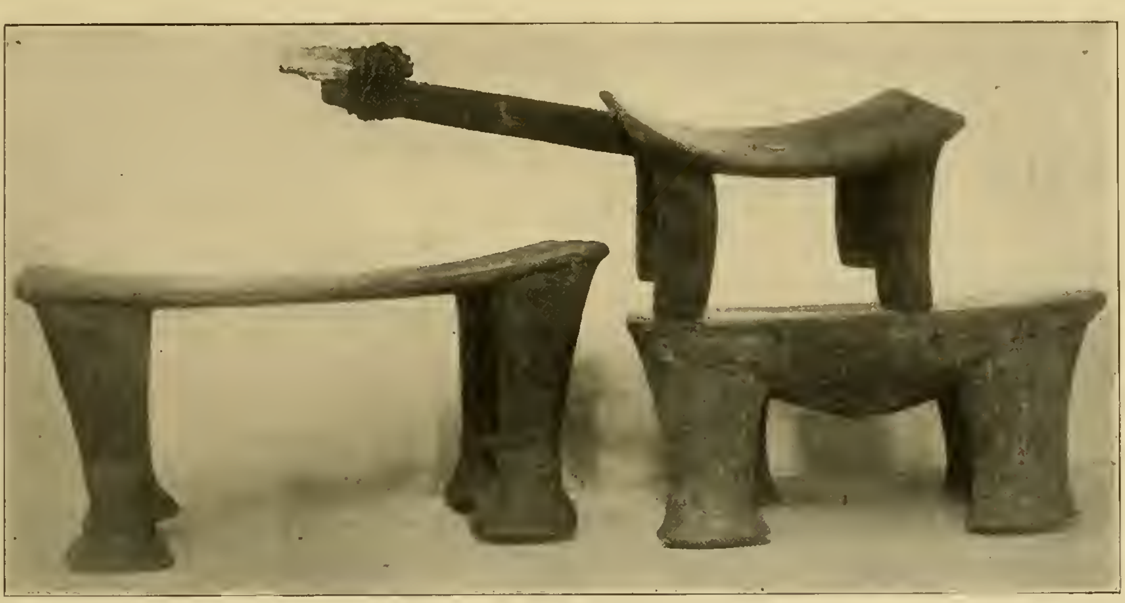


FIG. 178. POLYNESIAN STOOLS.

Omitting the last carved example, all the stools from the Polynesian groups are of one general pattern, and enough alike to suggest a common origin. The curved seat reminds one of the Central American *metate* or grinding stones, beautifully carved examples of which have been figured by Dr. Hartmann from Porto Rico. Some of these are light enough to be a petrifaction of the best Polynesian forms, except that they have generally three instead of four legs; four legs, however, sometimes occur on the American metate.

As we leave the Hawaiian house after taking an inventory of its contents, we shall probably see what we did not notice on entering, a rectangular flat stone lying so low on the stone kahua that one may be pardoned for thinking it a part of the house foundation, but a closer examination shows that its surface is marked with shallow pits in regular order and of considerable number. This is the *papamu*, a sort of checker board on which the game of *konane* was played, a game popular from ancient times all over the group, but especially on Hawaii, and it was common enough forty years ago to see two natives sitting on the stone platform near the house door intently playing this interesting game which somewhat resembled the Japanese game of gobang. The late King Kalakaua and his Queen Kapiolani were experts at konane, and it is well known that the goddess Pele did not refuse to play the game with the demigod Kamapuaa.

We have now filled the phantom house of the perished past with so much furniture that even the long house of the New Guinea Papuans would hardly contain it all, but surely any reader who has come with me thus far should be able to select such things as are needful for a primitive family even of an Alii. Unfortunately it is far easier to assemble the utensils than to call back the forms that once made and used them! The makaainana certainly lived a sordid life, without possessions, almost without rights, their gods less merciful, if possible, than their human masters the Alii, and yet they were never a gloomy or despairing people. Hard work they had, but many a game, and even the sports that none but the chiefs might take an active part in, they could and did enjoy as spectators. They were like children, and if their joyous moments were short in our view, their sorrows were equally short-lived, and the people who had a large-hearted chief had much reason to enjoy life and little to complain of.

With the Alii life must have been strenuous at times, for we know that war and devastating war was the rule for long periods before the conquest of the petty kingdoms into which the group and even the different islands were divided. There are those that claim that bloodshed developes the powers of a nation, and they point to the undoubted fact that the Hawaiians reached their highest development as a people after a long series of bloody wars, and that since peace has been established over the group, and one form and another of the Christian religion impressed upon the people, the chiefs, whose occupation seemed to have been taken from them, have disappeared wholly from the earth, and their people has ceased to be a nation and is fast following the chiefs.

Publications of the Bernice Pauahi Bishop Museum

All previous price lists are hereby cancelled.

A Handbook for the Bishop Museum. Oblong octavo, 94 half-tone illustrations. Price 25 cts., postage 9 cts.

Occasional Papers, Vol. I. Octavo.

No. 1. Director's Report, 1898. Visits to Ethnological museums in a journey around the world. [Out of print.]

No. 2. Director's Annual Report, 1899. Mat Sails of the Pacific—Stokes. Ray-skin Rasps—Walcott. Notes on the Birds of Oahu—Seale. Price 50 cts., postage 4 cts.

No. 3. Director's Annual Report, 1900. Visit to the American museums—Stokes. Mission to Guam—Seale. Notes on the Birds of Kauai—Bryan and Seale. Price $1.00, postage 8 cts.

No. 4. New Hawaiian Fishes—Seale. Price 25 cents; postage 2 cts.

No. 5. Director's Annual Report, 1901, and Index to Vol. I. Illustrations of sperm whale and bird groups. Price 50 cts., postage 4 cts.

Occasional Papers, Vol. II.

No. 1. Director's Annual Report, 1902. Noteworthy Hawaiian Stone Implements—Brigham. Fibres of the Hawaiian Islands—Blackman. Distribution and Variation of Achatinella multizonata—Cooke. Monograph of Marcus Island—Bryan. Price $1.00, postage 7 cts.

No. 2. Director's Annual Report, 1903. Remarks on Phallic Stones from Rapanui—J. L. Young. Aboriginal Wooden Weapons of Australia—Blackman. Price 40 cts., postage 4 cts.

No. 3. Director's Annual Report, 1904. Australian Bark Canoe—Brigham. A Stone Dagger for Duelling—Brigham. Notes on the Birds of the Waianae Mountains—Bryan. Additional Notes on the Nesting Habits of the Hawaiian Owl—Bryan. Description of the Nest and Eggs of Chlorodrepanis virens (Gmel.)—Bryan. Notes on the American Birds Collected in the Hawaiian Islands by Mr. Gerrit Wilder—Bryan. A Bird's Nest of Pele's Hair—Bryan. Two Undescribed Nests and an Egg of a Hawaiian Bird—Bryan. Price 50 cts., postage 5 cts.

No. 4. Director's Annual Report, 1905. Three New Hawaiian Fishes—Bryan. Report of a Visit to Midway Island—Bryan. Nest of Hawaiian Hawk—Bryan. Price 50 cts., postage 4 cts.

No. 5. Director's Annual Report, 1906, and Index to Vol. II. Dr. Cooke's Report on Types of Hawaiian Land Shells. Price 20 cts., postage 2 cts.

Occasional Papers, Vol. III.

No. 1. Reprint of Original Descriptions of Achatinella. By E. W. Thwing. Price $1.50, postage 9 cts.

Occasional Papers, Vol. IV.

No. 1. Fishes of the South Pacific—Seale. Price $1.00, postage 5 cts.

Memoirs, Vol. I. Quarto.

No. 1. Hawaiian Feather Work. By Wm. T. Brigham. Price $2.50, postage 14 cts.

No. 2. Index to the Islands of the Pacific. By Wm. T. Brigham. Price $1.50, postage 20 cts.

No. 3. Key to the Birds of the Hawaiian Group. By Wm. Alanson Bryan. Price $1.50, postage 13 cts.

No. 4. Ancient Hawaiian Stone Implements. By Wm. T. Brigham. Price $2.50, postage 20 cts.

No. 5. Supplement to Hawaiian Feather Work, with Index to Vol. I. By Wm. T. Brigham. Price 75 cts., postage 8 cts.

Memoirs, Vol. II.

No. 1. Hawaiian Mat and Basket Weaving—Brigham. Hawaiian Nets and Nettings—Stokes. Price $3.00, postage 20 cts.

No. 2. Old Hawaiian Carvings—Brigham. Price 50 cts., postage 5 c.

No. 3. The Ancient Hawaiian House. By Wm. T. Brigham. Price $3.00, postage 25 c.

14.372

MEMOIRS

OF THE

BERNICE PAUAHI BISHOP MUSEUM

OF

POLYNESIAN ETHNOLOGY AND NATURAL HISTORY

VOL. II—NO. 4

The Volcanoes of Kilauea and Mauna Loa

BY WILLIAM T. BRIGHAM, A.M., Sc.D. (Columbia)

HONOLULU, H. I.
Bishop Museum Press
1909

BOARD OF TRUSTEES

ALBERT F. JUDD	President
E. FAXON BISHOP	Vice-President
J. M. DOWSETT	Treasurer
ALFRED W. CARTER	Secretary

HENRY HOLMES, SAMUEL M. DAMON, WILLIAM O. SMITH

◆

MUSEUM STAFF

WILLIAM T. BRIGHAM, SC.D. (Columbia)	Director
WILLIAM H. DALL, PH.D.	Honorary Curator of Mollusca
JOHN F. G. STOKES	Curator of Polynesian Ethnology
C. MONTAGUE COOKE, PH.D. (Yale)	Curator of Pulmonata
OTTO H. SWEZEY	Honorary Curator of Entomology
CHARLES N. FORBES	Assistant in Botany
JOHN W. THOMPSON	Artist and Modeler
MISS E. SCHUPP	Librarian
JOHN J. GREENE	Printer

MOSES KAUAHI	Janitor
JAMES KALEI	Assistant Janitor

THE VOLCANOES
OF
KILAUEA AND MAUNA LOA
ON THE
ISLAND OF HAWAII

THEIR VARIOUSLY RECORDED HISTORY
TO THE PRESENT TIME

By WILLIAM T. BRIGHAM, A.M., Sc.D. (Columbia).

MEMOIRS OF THE BERNICE PAUAHI BISHOP MUSEUM
Vol. II. No. 4.

HONOLULU, H. I.
Bishop Museum Press.
1909

LIST OF PLATES.

Halemaumau, 1880. Furneaux. *Frontispiece.*
XLI. Views of Lava Fall and Its Work.
XLII. Descent into Halemaumau.
XLIII. Three Sentinels and Flow near Little Beggar. W. T. B.
XLIV. Two Views of Halemaumau.
XLV. Cone in Halemaumau. Pool Below Rim.
XLVI. Drawn Lava from Fall. W. T. B.
XLVII. Mass of Aa, Natural Size. W. T. B.
XLVIII. Cave Stalagmite, Slender Form. W. T. B.
XLIX. Cave Stalagmite, Thick. W. T. B.
L. Pool with Raised Walls. Silva.
LI. Pool of Halemaumau from Below, 1894.
LII. Pool in Halemaumau. 1894.
LIII. South Lake and Island.
LIV. Cone in Halemaumau.
LV. Cone in Halemaumau.
LVI. Cone in Halemaumau.
LVII. The Empty Pit.
LVIII. On the Brink of the Pit.
LIX. General View of Halemaumau.
LX. Dana Lake with Fountains.
LXI. South Lake.
LXII. Floating Islands.
LXIII. A Flow of Aa.
LXIV. Source of Flow of 1880-81.
LXV. A Crack in the Floor of Kilauea. J. J. Williams.
LXVI. Kilauea in 1896. Howard Hitchcock.
LXVII. Mokuaweoweo in 1896. Howard Hitchcock.

Of the photographs, some were taken by J. J. Williams; others are from negatives purchased by him. Those from photographs by the author bear his initials.

ILLUSTRATIONS.

PAGE
Map of Hawaii Showing Lava Flows 3
1. Old Flow West of Kilauea 4
2. Limu from Kilauea, 1789 5
3. Pots on Wailuku near Hilo 6
4. Mauna Kea from Waiakea, Hilo. Perkins 6
5. Cinder Cones on Mauna Kea 7
6. Pool on Mauna Kea, August, 1889 7
7. Summit of Hualalai from East 8
8. Pit Crater on Hualalai, 1889 9
9. Blow-hole on Hualalai, 1889 11
10. Hualalai from Mauna Loa (9000 ft.) 12
11. Mauna Loa from Top of Hualalai 13
12. Breaking Camp, Hualalai, 1889 15
13. Mauna Loa from Kilauea, 7 A.M 18
14. Halemaumau in 1888. Furneaux 20
15. Pele's Hair from Kilauea 21
16. Form of Less Fusible Lava 21
17. Rope Lava 22
18. Driblet under Lava Fall 22
19. Sectional Impression of Rope Lava 24
20. Palagonite from Diamond Head 25
21. Stony Cellular Lava 25
22. Lava with Cylindrical Cells 25
23. Vase Made from Molten Lava 26
24. Black Volcanic Sand 26
25. Basaltic Prisms in Wailuku Gorge 27
26. Halemaumau Smoking 28
27. Stalactites from Cave near Hilo 30
28. Stalagmites from a Cave in Kilauea 31
29. Blow-hole Specimen 32
PAGE
30. Fragmentary Lava 34
31. On the Old Trail to Kilauea 35
32. Section on Road North of Kilauea 37
33. Uwekahuna from Volcano House 38
34. Cracks at Ponahohoa. Ellis 39
35. Kilauea as Seen by Ellis 40
36. Ellis' View of Kilauea. Polyn. Researches 41
37. Dampier's Kilauea in 1825 44
38. Malden's Plan of Kilauea in 1825 45
39. Kilauea iki, Showing Lava Streams 47
40. Kilauea, by Parker & Chase. Dana 48
41. Wall on North of Kilauea 49
42. Map of Source of 1840 Eruption 51
43. Lava Around Trees in Puna. Henshaw 53
44. Kilauea in 1841. Wilkes 55
45. Kilauea in 1841. Drayton 56
46. Diagram in the Coan Letter 58
47. Lyman's Plan of Kilauea in 1846 59
48. Lyman's Revised Plan 60
49. Survey of Mokuaweoweo, 1841. Wilkes 64
50. The Cathedral from West and Northwest 75
51. Fountain, Feb. 6 and 7, 1859 76
52. Fountains Feb. 10, 1859 77
53. North End of Kilauea 80
54. Northern Sulphur Bank in 1889 81
55. Fumarole with Sulphur Crystals 82
56. Kilauea in 1864. Perry 83
57. Floor with Spatters 84
58. Bottom of Previous Fragment 85
59. Survey of Kilauea, 1865. Brigham 87

PAGE
60. Kilauea iki 89
61. Fragment of Flow of 1862 90
62. Keanakakoi in 1889 91
63. Craters at Kapoho, Puna 95
64. Crater Makaopuhi in Puna 96
65. Kapoho Craters 98
66. Green Pool, Puna 99
67. Warm Spring, Puna 100
68. Earthquake Ruins, 1868 103
69. Kilauea After Eruption, 1868 107
70. Lydgate's Survey of Kilauea, 1874 120
71. Crater of Kilauea 121
72. Mokuaweoweo. W. W. Hall 122
73. Lydgate's Mokuaweoweo 123
74. Kilauea in December, 1874 124
75. Kilauea in February, 1875 129
76. Crack in Floor of Kilauea, 1877 131
77. Sketch of Halemaumau, Jan. 1880 133
78. An Improved Volcano House. Williams 134
79. Kilauea in 1880. Furneaux 135
80. Northward from Southeast Lake 137
81. Diagram of Elevation 138
82. Halemaumau from Kau Bank, 1880 140
83. Lava Spring 141
84. Bath on Sulphur Bank, 1880. Silva 142
85. Mokuaweoweo Plan 144
86. Halemaumau in 1880. Furneaux 147
87. Diagram, Source of Flow, 1880 148
88. View of the Source. Furneaux 149
89. Lava Stream in a forest. Furneaux 150
90. Waterspout on the flow of 1881. Furneaux 152
91. Flow of 1881 near Hilo. Furneaux 153
92. Eruption from Kawaihae Bay. Furneaux 155
93. Little Beggar in 1889 157
94. Government Survey of Mokuaweoweo 159
95. Halemaumau After Eruption of 1886 163
96. Source of Eruption of 1887. Furneaux 165
97. Course of Flow of 1887. Furneaux 166
98. End of Flow of 1887. Furneaux 166
99. Survey of Halemaumau, July, 1888 170
100. Spatter Cone in Kilauea, 1889 172
101. Lava Fall North of Halemaumau 172

PAGE
102. Under East Wall of Kilauea 173
103. Pile of Crusts North of Halemaumau 173
104. Crack in Bed or Kilauea 174
105. Floor of Kilauea, 1890 175
106. About Halemaumau, 1890 176
107. Halemaumau After the Downfall 177
108. Cracks on the Brink of the Pit 179
109. New Portion of Volcano House 180
110. Halemaumau in October, 1891 181
111. Dodge's Survey of Halemaumau, 1892 182
112. Dodge's Survey from V. H. Register 183
113. Section of Halemaumau, 1892 184
114. Bishop's Plan of the Lakes 185
115. Comparative Sections 186
116. Section of Halemaumau, July, 1894 187
117. Outline of Island in Lake 189
118. Dodge's Survey of Halemaumau, '94 190
119. Dodge's Survey: another copy 191
120. Friedländer's Mokuaweoweo in 1896 193
121. Friedländer's Mokuaweoweo by Night 194
122. Map of Mokuaweoweo, 1896 195
123. Map of Halemaumau 197
124. Hitchcock's View of Eruption 199
125. Eruption of Mokuaweoweo by Day 201
126. Eruption of Mokuaweoweo by Night 201
127. Map of Eruption 203
128. Camp on Mauna Loa, 1905. Pope 204
129. Halemaumau in December, 1906 205
130. Western Wall of Mokuaweoweo. Pope 206
131. Eastern Wall of Mokuaweoweo. Pope 207
132. Moving Mass of Aa in 1907. Perkins 208
133. Front of Aa Flow, 1907. Perkins 208
134. Thurston's Plan of Fire Pool 209
135. Biart's Plan of Fire Lake 209
136. Halemaumau, August, 1908. Perkins 210
137. Surface of Lava by Night. Perkins 211
138. Surface of Lava by Night. Perkins 211
139. Halemaumau from Northwest. Perkins 213
140. Halemaumau Before the Break. Thrum 214
141. Halemaumau, August, 1909. Reed 215
142. Section of Fire Pit. Baldwin 217
143. Lydgate's Survey of Halemaumau 219

INDEX

PAGE
Aa 4, 16, 77, 96
Alexander, Mauna Loa in 1885 158
Analysis of stalactites 32
Analyses of lavas 33
Ancient walls of Kilauea 49
Anderson, Kilauea in 1909 218
Andrews, Mauna Loa in 1843 63
Augite 23, 29
Baldwin, plan of Kilauea in 1908 217
Baker, Mauna Loa in 1880-81 148, 171
  Mauna Loa in 1885 157
Basalt, character of Hawaiian 23
  prismatic 24
Bishop, Mauna Loa in 1868 104
  plan of Kilauea 184
Black sand 27, 74
Blow-hole on Hualalai 11
Brigham, Hualalai in 1864 9
  Hualalai in 1889 13
  Kilauea in 1864 80
  in 1865 88
  in 1880 134
  Mauna Loa in 1864 15
  Mauna Loa in 1880 19, 143
Byron, Kilauea in 1825 44
Carbonic acid 29
Caves in lava 92, 97, 99
Cathedral cone 75, 88
Centrifugal motion of lava in Kilauea 86
Challenger Expedition, Kilauea in 1875 129
Chase and Parker, Kilauea in 1838 47
Chlorine 29
Chronological history of the eruptions of Kilauea and Mauna Loa 36
Cinder cones of Mauna Kea 5, 27
Clinkstone 24
Coan, Kilauea in 1840 50
  in 1842 57
  in 1844, 1846 58
  in 1847, 1848 61
  in 1849-1854 62
  in 1855 68
  in 1856-1863 74, 75
  in 1868 117
  in 1869 119
  Mauna Loa in 1843 64
  in 1849, 1851, 1852 65
  in 1855 68
  in 1856 71
  in 1868 114
  in 1875, 1877 127
  in 1880 146

PAGE
Coan, Kilauea in 1881 151
  earthquake of 1868 112
  tidal wave of 1868 113
  landslide of 1868 114
Cross, Kilauea in 1902 200
Dana, Kilauea in 1840 55
Dana Lake 169, 184
Deaths from eruptions 14, 38
  from land slide and tidal wave 109, 118
Dibble, eruption of 1789 38
Dodge, surveys of Kilauea 169, 186, 189
Dolerite 23
Dome in Kilauea 60-62, 138, 222
Douglas, Kilauea in 1834 47
  Mauna Loa in 1837 63
Earthquakes of 1868 101
  of 1887 165, 167
Electric action on lava 33
  currents in the lava 93
Elevation of Kilauea dome 60-62, 137
Ellis, Hualalai 9, 12
  Kilauea in 1823 40, 41
Emerson, Kilauea in 1886 162
Erosion of lava flows by the sea 4
Ferrous oxide 29
Flames in Kilauea 86, 139
Floating islands in lava 178, 188, 189
Flow of 1801 8, 14
  of 1823 40
  of 1823 100
  of 1840 51
  of 1843 64
  of 1852 65
  of 1855 68
  of 1859 75
  of 1868 101
  of 1880-1881 147
  of 1887 165
  of 1899 196
  of 1907 206
Forms of lava 23-34
Frear, Kilauea in 1894 189
Friedländer, Mauna Loa in 1896 192
Fumaroles 27, 81, 169
Furneaux' paintings 19, 139, 148, 155, 167, 171
Gases from volcanoes 27, 139
Gibson, Kilauea, 1895 130
Goodrich, Kilauea in 1832 46
Green, on vapors from Kilauea 28
  Mauna Loa in 1859 78
  Mauna Loa in 1873 126
  Mauna Loa in 1875 127

PAGE
Green Lake 97
Halemaumau 46, 49, 97
Halema'uma'u 97
Hall, Mauna Loa in 1873 122
Haskell, Mauna Loa 75
Hillebrand, Kilauea in 1868 106
  earthquake of 1868 106-110
  flow of 1868 111
History of eruptions, chronological 36
Hitchcock, C. H., Prof., Mauna Loa and Kilauea in 1883 156
Hitchcock, D. H., Mauna Loa in 1881 149
Hitchcock, D. Howard, paintings 73, 186, 192
Hualalai, flow of 1801 8, 14
  ascent by Menzies 8
  ascents by Ellis, Mann and Brigham 9
Hydrochloric acid 29
Hydrogen 28
Ingalls, Mauna Loa in 1899 196
Judd, escape at Kilauea in 1841 57
Kahuku eruption of 1868 111, 114
Keanakakoi 90, 91, 132
Kilauea in 1789 36
  in 1823 40, 100
  in 1824 42
  in 1825 43
  in 1829 46
  in 1832 24, 46
  in 1834, 1838 47
  in 1839 49
  in 1840 50
  in 1841 56
  in 1842 57
  in 1844, 1846 58
  in 1847, 1848 61
  in 1849-1854 62
  in 1855 68
  in 1856-1863 74, 75
  in 1864 80
  in 1865 88
  in 1868 100, 106, 113, 117
  in 1869-1872 119
  in 1873 119-123
  in 1874 123-125
  in 1875 128
  in 1876-1877 130
  in 1878-1879 132
  in 1880 133, 146
  in 1881 155
  in 1882-1884 156
  in 1885 157
  in 1886 162
  in 1887 168
  in 1888 168, 171
  in 1889 174
  in 1890 174, 175
  in 1891 175
  in 1892 184
  in 1893, 1894 185
  in 1895 192
  in 1896 192, 196
  in 1897 196

PAGE
Kilauea in 1898, 1900 199
  in 1901, 1902 200
  in 1903 202 204
  in 1904, 1905 204
  in 1906 206
  in 1907 209
  in 1908 209, 217
  in 1909 217
Kilauea iki 42, 46, 89, 108, 130
Kinnear's sketch of Halemaumau 133
Kinney and Fuller, flow of 1852 67
Landslide, 1868 102, 109, 114
Lava analyses 33
  of Hawaii, character 23
  forms 23, 34
  fountains of Mauna Loa 77
  spring 141
Limonite 29
Limu, Hawaiian pumice 4, 79, 92, 144
Little Beggar 157
Little Elephant cone 171
Loomis, Kilauea in 1824 42
Lua Pele 61
Lydgate, plans of Kilauea 119, 129, 218
  plan of Mokuaweoweo 123, 145
Lyman, C. S., Kilauea in 1846 58, 61
Lyman, F. S., earthquakes of 1868 101
Magnetite 23
Makaopuhi crater 54, 97
Mann and Brigham, Hualalai in 1863 9
  Kilauea in 1864 80
  Mauna Loa in 1864 15
Mauna Hualalai, see Hualalai.
Mauna Kea 5
Mauna Kohala 5
Mauna Loa, area 161
  ascent by Douglas in 1834 47
  in 1832-1837 63
  in 1841 17, 63
  in 1843 63
  in 1849, 1851, 1852 65
  in 1855 68
  in 1856 71
  in 1859 75
  in 1864 15
  in 1868 101
  in 1868-1872 125
  in 1873 120, 122, 123, 126
  in 1874 123, 124
  in 1875-1877 127
  in 1879 132
  in 1880 19, 133, 143
  in 1880, 1881 147
  in 1885 157, 158
  in 1887 165
  in 1888 168
  in 1890 174
  in 1892 185
  in 1896 192
  in 1899 196
  in 1903 202
  in 1905 204

PAGE
Mauna Loa in 1907 ... 206
Menzies' ascent of Hualalai ... 8
Merritt, Mauna Loa, 1888 ... 168
Mica ... 23, 29
Minerals from Hawaiian volcanoes ... 29
Model of Kilauea ... 201
Mud-flow, 1868. See Landslide.
Observatory at Kilauea ... 118
Old Faithful ... 189
Olivine ... 23, 29, 54, 84
Pahoehoe ... 2, 24
Pele's hair ... 17, 23, 33, 85, 137
  analyses ... 33
Phonolite ... 24
Pickering, Kilauea in 1841 ... 56
Pit craters of Hualalai ... 10
  in Puna ... 94
Pohaku Hanalei crater ... 143, 204
Poli o Keawe crater ... 93
Ponahohoa ... 40, 140
Pope, Mauna Loa in 1905 ... 204
Prismatic basalt ... 24
Pukauahi crater ... 148
Pulu ... 93
Pumice, see also Limu ... 23
Puna, legendary lava flows ... 99
  pit craters ... 94
Quartz ... 29
Radium ... 180
Rate of landslide ... 102, 114
Rate of lava flows ... 14, 51, 67, 69, 70, 72, 73, 75, 76, 105, 116, 140, 151, 153, 167, 206, 207
Ridgeway's plan of Mokuaweoweo ... 202
River beds changed ... 4
Rope-lava ... 23, 24
Salts in lava ... 14, 29, 54, 69, 117

PAGE
Schaefer, Kilauea in 1874 ... 124
Scoria ... 27
Scott's sketch of Kilauea ... 129
Severance, plan of Mokuaweoweo ... 145
Shepherd, Kilauea in 1839 ... 49
Snow on Mauna Kea ... 5
  on Mauna Loa ... 18, 76
Stalactites and stalagmites ... 29, 93
Steam, volcanic ... 27, 28, 127
Stewart, Kilauea in 1825 ... 43
  in 1829 ... 46
Stony lavas ... 24
Strzelecki, Kilauea in 1838 ... 48
Sulphide of iron ... 29
Sulphur beds ... 54, 82, 91, 140
Sulphurous acid gas ... 28
Thurston, Kilauea in 1894 ... 187
  Mauna Loa in 1890 ... 174
Thurston Lake ... 185
Tidal wave, 1886 ... 103, 113
  of 1872 ... 125
Toler, Kilauea in 1877 ... 130
Traveling fountains ... 217, 221
Tree moulds of lava ... 16, 52, 96, 111, 202
Tufa ... 24
Van Slyke, Kilauea, 1886 ... 164
Vapors from volcanoes ... 27
Vegetation on Hualalai ... 10, 12
  on Mauna Loa ... 19
Volcanic sand ... 27
Waldron's Ledge ... 83
Warm springs ... 14, 98
Whitney, Mauna Loa in 1868 ... 105
Wilkes, Kilauea in 1841 ... 56
  Mauna Loa in 1841 ... 17, 63

KILAUEA AND MAUNA LOA.

Their recorded History to 1909. *By* WILLIAM T. BRIGHAM, SC.D., *Director of the Bernice Pauahi Bishop Museum.*

AT the request of the Trustees of this Museum the author of the following account has returned to his studies of nearly half a century ago when, in company with the late Horace Mann, he came to these islands to explore the Geology and Botany of the Group. He is the more ready to continue the record then started because he has collected much additional information and made many photographs illustrating the subject that seem worth preserving, and there are errors in his and other publications on the Hawaiian volcanoes that need correction. The result is offered in a form as free as possible from tentative theorizing; it is mainly a collection of material for other geologists to use at their discretion in elucidating, as far as it may serve, those deeper problems often touched but as yet unsolved,—the source of volcanic heat, the cause of the rise and outflow or ejection of the matter usually classed as volcanic,—on these Geology has no positive knowledge.

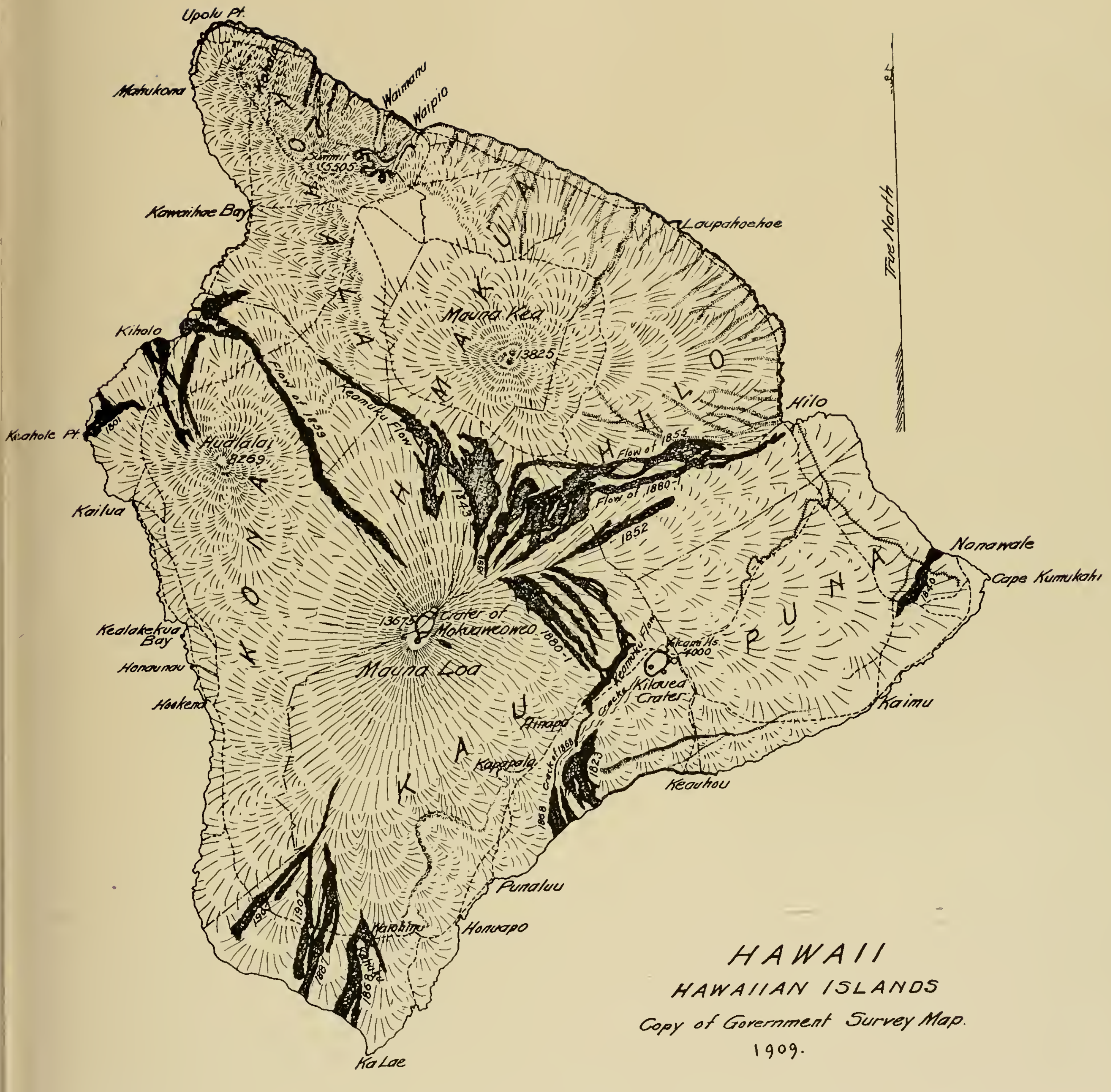
When the results of this early exploration by the author on the geological side were published in 1868, followed by a later paper on the same theme in 1869,[1] no thought was entertained of any return to the scenes of these most enjoyable journeyings, but in 1880 an expected eruption of Mauna Loa brought him back with the artist Mr. Charles Furneaux, and eight years later he returned to make Honolulu his residence. All the time from 1864 to this writing he has kept in touch with the Hawaiian Islands, and although his active work has turned aside from vulcanology in great measure, yet his visits to the Halemaumau of Kilauea have now numbered more than forty during these years. Journeyings through the wonderful volcanic region of Central France and along the Rhine; to Vesuvius; a sight of Ætna, Stromboli and the Campi Phlegræi, and a more careful reconnaissance of the Guatemalan volcanoes; and not least, a journey through the entire volcanic region of the northern island of New Zealand, have kept alive an interest in volcanic matters which was kindled by a careful survey of Kilauea in 1865. If little new be added to the story, some corrections authorized by greater knowledge, and perhaps a more orderly arrangement of the material in hand, may be a sufficient apology for attempting in this paper to carry on to the present year some of the admirable work of the author's friend, the late James Dwight Dana, whose name is identified with Hawaiian vulcanology. His disquisition on Volcanic Characteristics is easily accessible and need not be repeated here: the petrology may also be omitted, for the knowledge of the intimate structure of rocks is greatly increasing year by year, and many have written thereon. Here the reader may look only for a connected story of the activities of the Hawaiian volcanoes in historic times, with all the accuracy at the writer's command from a long familiarity with the visible phenomena and the written record and a personal acquaintance with most of those whose testimony is quoted.

---

[1] Memoirs of the Boston Society of Natural History, vol. I, pt. 3: Ibid, vol. 1, pt. 4. The publication of the full results of the botanical part was stopped by the lamented death of Mr. Mann, whose Enumeration of Hawaiian Plants, published in the proceedings of the American Academy of Arts and Sciences, procured him the honor of an election as Fellow of that Academy. A Flora of the Hawaiian Islands was partly published by the Essex Institute at the time of his death.

The Island of Hawaii.

To those who are not familiar with the geography of Hawaii a glance at the map will render clearer my explanation. The area, 4015 square miles, is wholly composed of the lavas poured out by the five volcanoes which rise 31,000 feet from the bed of the ocean, and nearly 14,000 from its surface. Not all crude lava, for ages of decomposition and the wear and tear of the elements, with the rapid work of the vegetable transformer have made soil of great fertility and suited to many crops, so that if many of the higher ridges are devastated by the lately molten rock not yet relieved of its savage form, the valleys present all the beauties of a tropical vegetation. Here are the few rivers, especially on the northern or windward side, that the island can boast, and in their course are many and most picturesque waterfalls. If rivers of water are uncommon over three-quarters of the island, rivers of stone are sufficiently apparent to indicate the process by which the island has been formed. In the newer parts the lava streams are everywhere, and in some places they have cut through the forests and made their way to the sea, as will be seen in the course of our studies of the volcano in action. Often the traveler in the uplands comes across a mass of jagged and apparently lawless rock (Fig. 1), impassable for his horse, almost for himself: all our modern resources of explosives could hardly work such disorder, such desolation. As he cannot cross the frozen lava stream just here he may follow it up and at last come to a portion of the flow where the surface is comparatively smooth where he and his horse can walk as on a paved street, a surface the natives call *pahoehoe* (see Pl. XLI), and the name has so completely supplied a want in our vocabulary that, in spite of the


Upolu Pt.
Mahukona
Waimanu
Waipio
Summit 5505
Kawaihae Bay
Laupahoehoe
True North
Mauna Kea
13825
Kiholo
Flow of 1859
Keamuku Flow
Hilo
Keahole Pt.
1801
Hualalai
8269
Flow of 1855
Kailua
Flow of 1880-1
1852
1843
Nanawale
Cape Kumukahi
1840
Kealakekua Bay
13675
Crater of Mokuaweoweo
1880-1
Honaunau
Kilauea Hs. 4000
Kilauea Crater
Mauna Loa
Hookena
Kaimu
Ainapo
Crack of 1868
Kapapala
1823
Keauhou
1868
Punaluu
1907
Kahuku
Honuapo
1887
1868
Ka Lae
KOHALA
HAMAKUA
HILO
KONA
PUNA
KAU

HAWAII

HAWAIIAN ISLANDS

Copy of Government Survey Map.

1909.

objurgations of an English geologist, it has been adopted by all geologists treating of the Hawaiian lavas. Another native word, *a-a*, supplies another want, for nowhere in the English language is there a word expressive of the roughness of the rock mass to which this word is applied (Pl. XLVII); a third, *limu*, meaning moss or seaweed, is well applied to the basaltic pumice which accompanies all the Hawaiian *outbursts* of lava (Fig. 2). Now the rough scoriæ, a-a and limu, quickly invite vegetation when moisture is present, and do their best to cover the ravages of Pluto with the garments of Ceres, but the smooth lava does no such good work, although pleasanter to walk upon; only when its great slabs, smooth or slightly wrinkled in the cooling process, are cracked, can the vegetable get a footing. We will return to the forms and nature of the lava later with such help as flat pictures can give the reader.

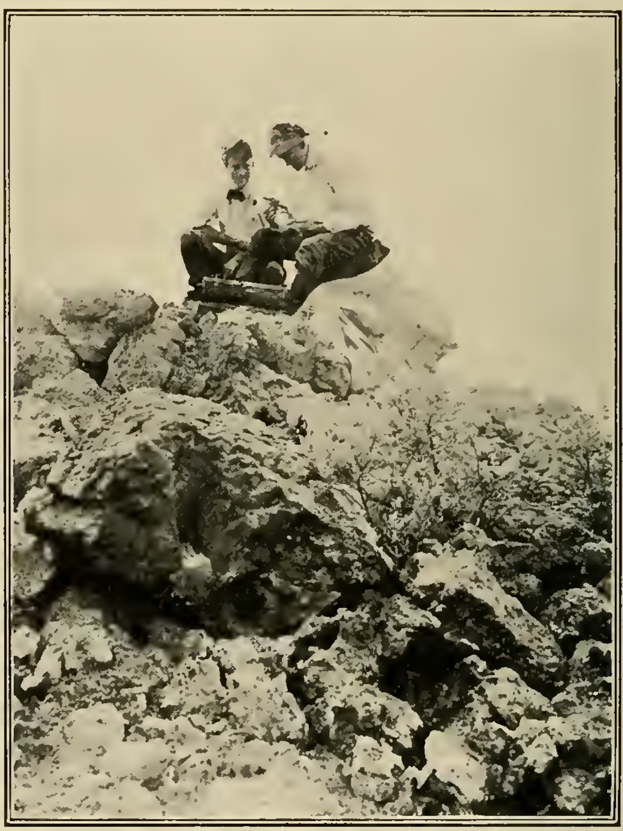


FIG. 1. OLD FLOW WEST OF KILAUEA.

While rivers of water irrigate and support the vegetation in the lower valleys, they, in bringing down soil, of course erode the hills and cut the valleys deeper; a process Dana has well illustrated from the erosion of one of the Pacific islands. The rivers of stone build up and often where the river has cut a channel on this island, as in the case of the Wailuku at Hilo, we see a contest between the destruction and the renewal. Within historical times the river has more than once been wiped out by the fiery flood, and has patiently set to its work of cutting a new channel (Fig. 3).

It is easy to see that the constant outpour of lava from a group of volcanic vents would not only increase the height of an island but its circumference as well in an even proportion were there not some check to the latter increase. The check in the present case is the erosive power of the sea currents and waves. Hawaii is not protected by a fringing coral reef, for owing to the frequent submarine eruptions as well as to the flows that rush down the mountain sides and push out the shore line, the coral polyp does not generally flourish as around the islands where active volcanic growth has ceased, consequently there is no natural breakwater to the strong action of currents and waves. However hard the surface of a lava stream where it meets the sea, its physical structure is such that the waves find easy access to the bubbles, hollows, caves, so common in its structure, and after presenting water spouts for years perhaps, the almost ceaseless beating of wave succeeding wave demolishes and sweeps away the ruins. It is probable that Hawaii is not growing from accretions of lava along shore more than it is wasting by marine erosion.

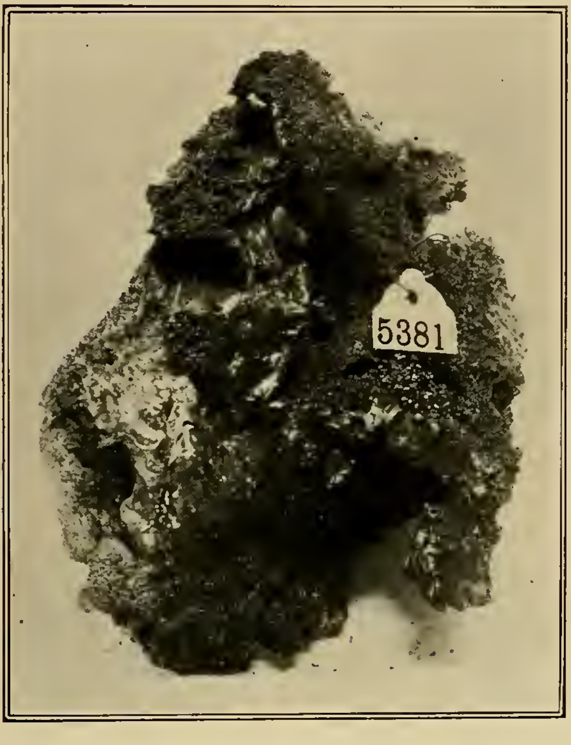


FIG. 2. GREEN LIMU FROM KILAUEA, 1789: NATURAL SIZE.

The time is near at hand for a more complete physiographic sketch of the Hawaiian group than has hitherto been possible, but at the present the portion that most interests us is the cluster of mountain peaks which marks the site of the orifices from which the building of the island of Hawaii (where alone are active volcanoes) has been effected. There are five of these mountains prominent on the face of Hawaii. In the northwest Mauna Kohala, or Mt. Kohala, has long been extinct and its slopes to the eastward have been buried beneath the lava streams from its mighty neighbor on the northeast, Mauna Kea (White Mountain). The summit of Kohala shows little sign of volcanic action, is swampy, and the source of much water used for irrigation. Its height is 5489 feet, but little more than that of Kilauea on the southeast.

Mauna Kea (Fig. 4) also has long been extinct and its summit is covered with cinder cones (Fig. 5), most of them with deep craters filled all the year with snow which supplies the summit pool occupying the only crateriform depression on the summit (Fig. 6). Its depth is not known, as the only party which has made the ascent when the pool was frozen over, so far as the author is informed, neglected to ascertain this interesting measure. Usually considered the highest of the Hawaiian volcanoes (13,825 feet), its mass is less, and its real summit lower than that of Mauna Loa (13,675 feet), only the cinder cones give the superior height, and as these are composed of loose cinder

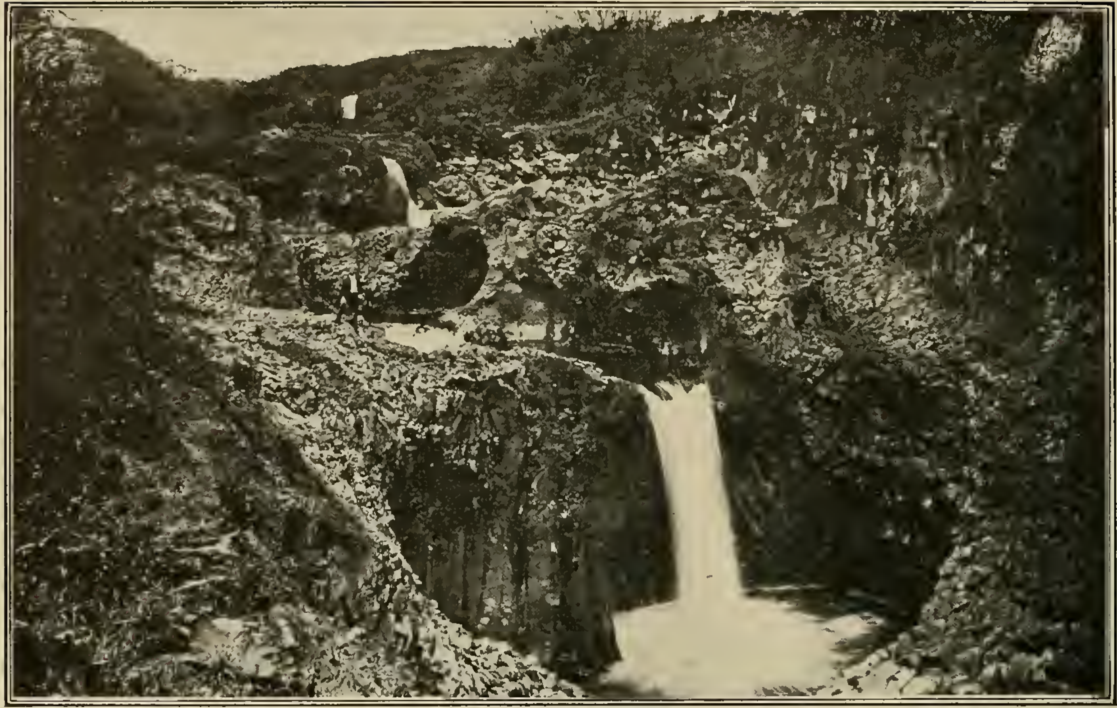
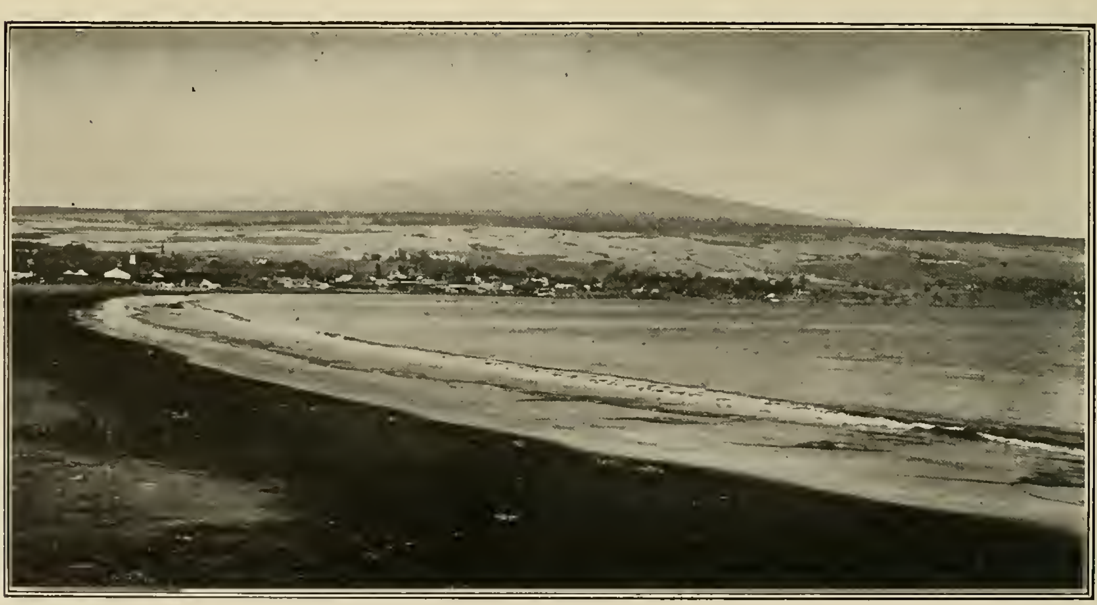


FIG. 3. THE POTS ON THE WAILUKU NEAR HILO.



Perkins.

FIG. 4. MAUNA KEA FROM WAIAKEA, HILO.

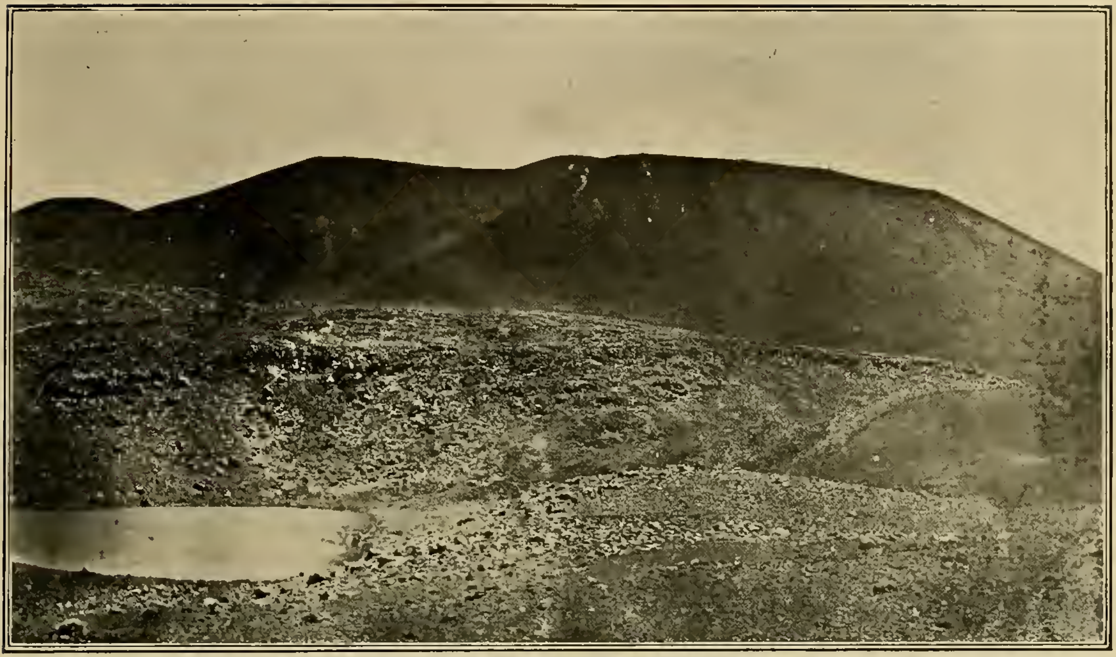


FIG. 5. CINDER CONES ON MAUNA KEA.

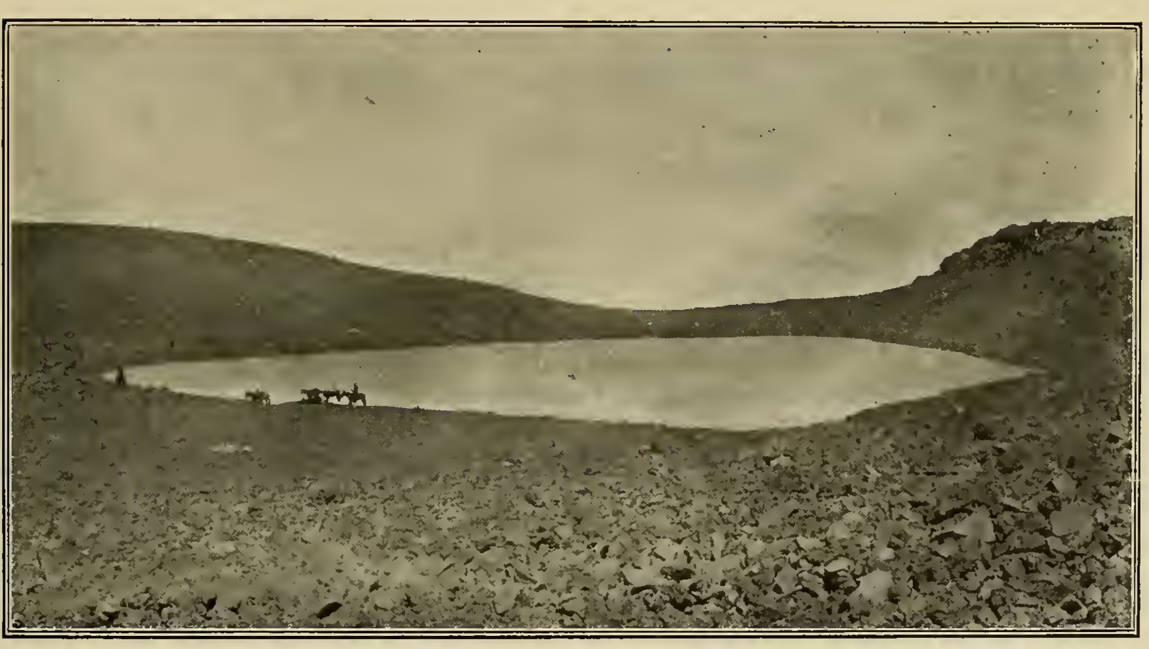


FIG. 6. THE POOL ON MAUNA KEA IN AUGUST, 1889.

they are slowly settling and in time will dispose of all claims to superior elevation. From the base of the cones on Kea the mass of Loa seems not only grander but higher as well. The sides of Kea are dotted with lateral cones making her appear, like Ætna, a "Mother of Mountains."[2]

As one sails up the western coast of Hawaii it is difficult to see where Mauna Loa ends and Mauna Hualalai begins, but at Kailua its distinct and cone-crowned summit rising to the height of 8275 feet, marks its individuality. This mountain has been quiescent for many years, but unlike Kohala and Kea, of whose former activity not even native legends are known, it has been in eruption within the period when white men have had knowledge of this group. Its history is, however, brief, and the exact date is uncertain on which the last eruption occurred. From both natives and missionaries the author obtained the date of 1801. Others have given 1800 and 1803. Ellis says, "about twenty years ago" in describing his visit in 1823, so it may be considered to have occurred very early in the nineteenth century. A party of naturalists from Vancouver's expedition, led by Mr. A. Menzies, made the first ascent in January, 1794. The account of this given in the narrative of Vancouver's voyage is meagre, the entry under date of January 26 being:

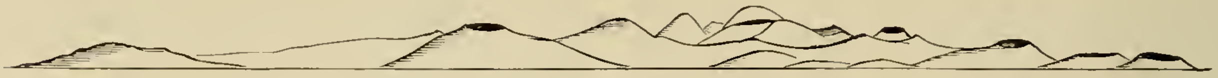


FIG. 7. SUMMIT OF HUALALAI FROM EAST.

> The party accompanying Mr. Menzies returned with him on Saturday, after having had a very pleasant excursion, though it had been somewhat fatiguing in consequence of the badness of the paths in the interior country, where in many places the ground broke in under their feet. Their object had been to gain the summit of Mowna Roa [Mauna Loa], which they had not been able to effect in the direction they had attempted it; but they had reached the top of another mountain, which though not so lofty as Mowna-rowna [Mauna Loa] or Mowna kaah [Mauna Kea], is yet very conspicuous, and is called by the natives Worroray [Hualalai]. This mountain rises from the western extremity of the island, and on its summit was a volcanic crater that readily accounted for the formation of that part of the country over which they had found it so dangerous to travel.[3]

Vancouver gives an engraving of a crater on Hualalai, but it has not been identified. Menzies was a botanist and not a geologist, and his journals are preserved in England from which we learn much of the vegetation of this trip, but little or nothing of the geological condition of this volcano.[4]

---

[2] In 1889 the author made the ascent of Mauna Kea from the Hilo side and found it very easy on horseback. From the Waimea side the ascent is shorter and easier.

[3] A Voyage of Discovery to the North Pacific Ocean and round the World. London, 1798, vol. III, p. 14.

[4] A portion of his journals has been reprinted in Thrum's Annual for 1908.

The Rev. William Ellis made the ascent in 1823, and his account will be quoted later, but as the present writer had more in view the geology of the mountain, he will first give his own account of the ascent made thirty-eight years later, though still during the life of this excellent missionary who read and approved the account that follows.[5]

On Thursday afternoon, July 28, 1864, Mr. Horace Mann and myself, with a native guide left Kaawaloa. Our way led at first through open pastures, then through tracts of tall ferns, and finally we came to the forest, where the soil was black and muddy, and the bushes so close as to almost prevent our passage in some places—gigantic raspberries (*Rubus hawaiiensis*) with stems two inches in diameter at the base and more than twenty feet long, hung across our path and often scratched both ourselves and our horses in spite of our precautions. It rained hard so that we were quite wet, and the clouds prevented our seeing much on either side. After some six miles of forest, we came upon a bed of a-a, fresh-looking and rough, and the trees were thinner and smaller. We were now on a dismal plain of pahoehoe and gravelly sand, where in the scotch mist we could see but little out of our path. This was the elevated plain between the mountains, and being at least 5000 feet above the sea the atmosphere was cold as well as damp.

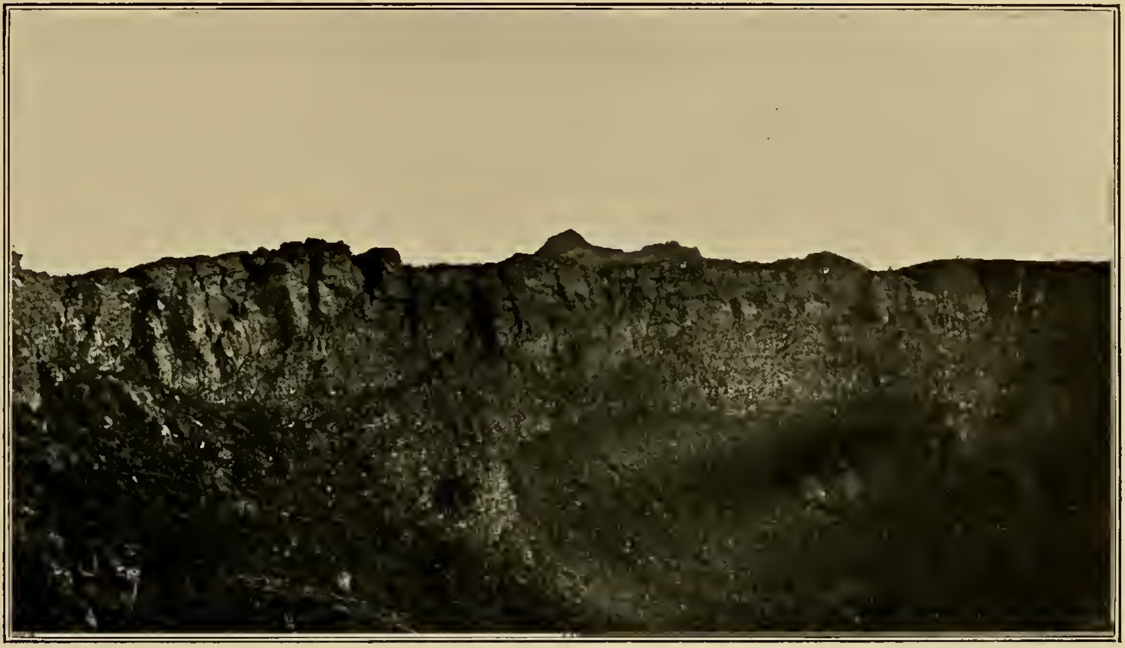


FIG. 8. PIT CRATER ON HUALALAI, 1889.

---

[5] This account was first printed in the Memoirs of the Boston Society of Natural History, vol. I, p. 380.

A leguminous tree (*Sophora chrysophylla*), called by the natives Mamane, was common; the sandal-wood was seen here and there, but of small size, and the ohelo (*Vaccinium penduliflorum*) covered the ground thickly, and was loaded with its large red and purple berries. Twisted lava streams, and masses of scoriæ crossed our path, and so complicated were they that it was almost impossible to trace their course. About sunset we came to the place our guide had selected for our camp, and we soon had a fire at which we dried ourselves and roasted some sweet potatoes, and as the rain had ceased, slept comfortably under some bushes. Our water came from a curious pool in the last place one would think of looking for water, in the midst of a horribly rough bed of scoriæ almost as porous as pumice, and broken into irregular masses of all sizes. The basin holds about twelve gallons of cold, pure water, and has no evident inlet or outlet, yet is never entirely exhausted; we nearly emptied it and the next morning it was full again. It was found accidentally, and three columns of stone are piled up to mark the place, which would be most difficult to find without these signals.

At half-past five in the morning we started for the summit, toward which a good path led for some distance, and we galloped over the hard gravel beds, dodging in a zigzag course the clumps of bushes in our way. The morning was clear, and the birds, which are scarce near the shore, were abundant, and sang merrily. The path ended after three miles, and we had to slowly pick our way over difficult and even dangerous lava-fields. Our horses occasionally broke through, causing some trepidation to the riders, but no accidents occurred; and after passing nearly round the summit, crossing the flow of 1801, and counting ten flows from the top, and many others almost indistinguishable, we reached the base of the highest plateau at eight o'clock, and left our horses in a little valley where strawberries were abundant, and also American potatoes, planted by some native.

A climb up a steep slope some three hundred feet high, and we were in the midst of a series of large pit craters extending over the entire summit. These craters were very much alike, from three to five hundred feet deep, and from seven hundred to a thousand feet in diameter. The walls were of solid grey lava capped very seldom by more recent basalt (although fresh looking lava was piled near by), and were nearly perpendicular. Vegetation extended to the bottom, and the beautiful Silver-sword (*Argyroxiphium sandvicense*) was growing in the clefts far down the sides. The bottom was usually flat and gravelly, but in some cases covered with smooth black lava, and in others rough and broken. Fragments of the walls were often seen at their base, and in one crater they were partly melted into the fresh lava which covered the bottom, proving that the compact lava of this mountain summit is fusible by the melted black basalt.

No signs of steam or sulphurous fumes were visible, but on the edge of one of the deepest craters, on the wall which separated it from another less than two hundred feet distant, was a mound of scoriæ some fifty feet high, composed of drops and slightly agglutinated fragments of all sizes and colors, black, blue, orange, red, golden, apparently ejected in a viscid state, and in the centre of this a blow-hole about twenty-five feet in diameter, and as nearly as we could judge by throwing stones, eighteen hundred feet deep to a ledge, to one side of which we could see a deeper, rather smaller hole.

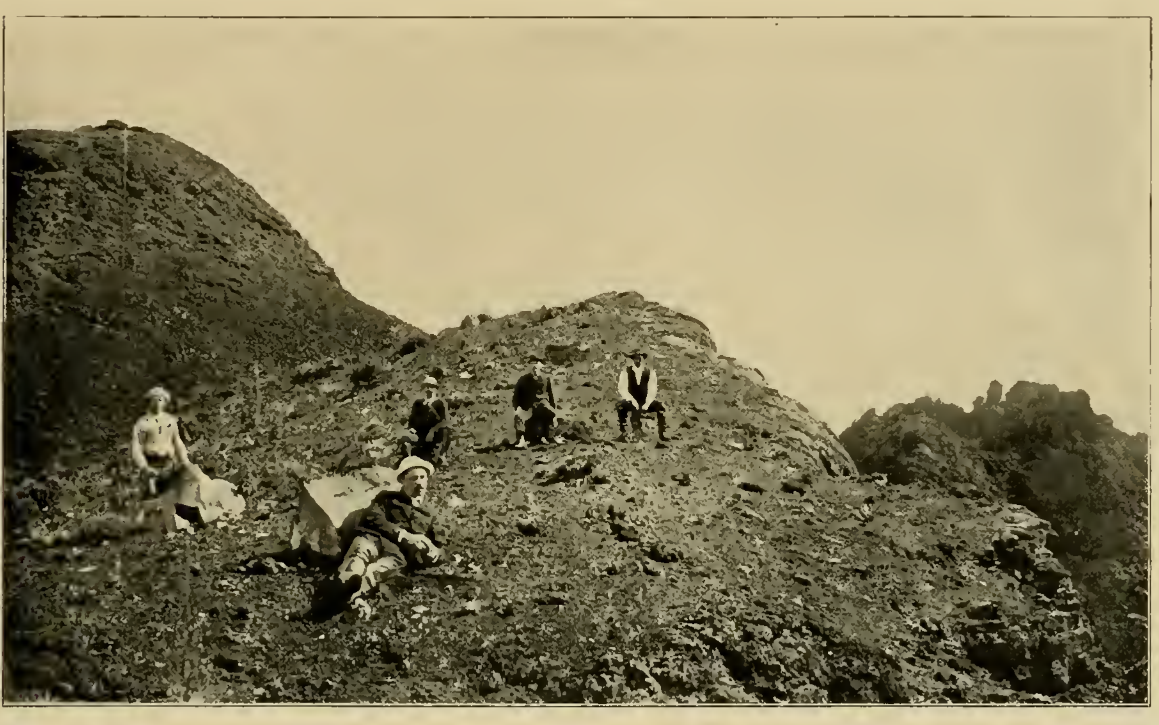


FIG. 9. BLOW-HOLE ON HUALALAI. FROM A PHOTOGRAPH TAKEN IN 1889.

I was obliged to lie flat on the edge to examine it, the scoriæ were so loose, and the whole cone jarred as we climbed over it.[6] The inside of the blow-hole was of a brown color, smooth as if turned, and grooved horizontally. No vertical striæ could be distinguished, but as these horizontal grooves seem to correspond to the strata of the adjoining crater walls, I suppose that the projecting ridges mark the more solid substance of these strata which would be in their centre, while the scoriæ which separate the beds to some extent, would permit the deeper action of the vapors that have formed the hole. The wearing force must have been chemical rather than mechanical, as the wall of the crater adjoining, which is not more than twenty-five or thirty feet thick, would have given way to any violent explosion. (Fig. 9.) A similar blow-hole was described by Ellis lower down the mountain. He ascended Hualalai in 1823 and found on the side of the mountain a large extinguished crater, about a mile in circumference and apparently four hundred feet deep. The sides were regularly sloped, and at the bottom was a mound with an aperture in its top. By the side of this large crater, divided from it by a narrow ridge of rock, was another, fifty-six feet in circumference, from which volumes of sulphurous smoke continually ascended. No bottom could be seen, and on throwing stones into it they were heard to strike against its sides for eight seconds. There were two other apertures very near this, nine feet in diameter, and apparently two hundred feet deep.[7] This corresponds so nearly with the blow-hole we saw on the summit that it is almost certain that vapors formed or at least enlarged both.

---

[6] When I again visited this blow-hole twenty-five years later the top had fallen in, much reducing the height. This was a favorite depository among the ancient natives for foreskins, umbilical cords, etc., and tradition declares that not a few of the idols doomed to destruction were cast into this almost sacred hole as preferable to the usual cremation.

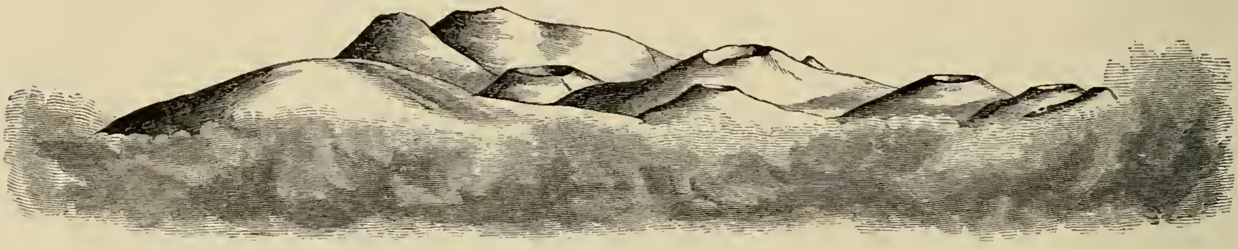


FIG. 10. THE SUMMIT OF HUALALAI SEEN FROM MAUNA LOA (9000 FEET).

From the vegetation of the summit I should not consider Hualalai more than 8500 feet high,[8] although some have placed it at 10,000. It is covered with lateral cones and its summit is flat, with many pit craters. More than one hundred and fifty lateral cones have been counted and it will be seen from the sketch made from the slopes of Mauna Loa the same summer that they vary both in size and in slope.

In the afternoon we camped about a mile from our last night's resting place, between two cones. Our guide shot two of the native geese (*Nesochen sandvicensis*), which were fine eating. The number of these geese has been much underrated. Although they are found only on the highlands of Hawaii and Maui, their number admits of the annual slaughter of several hundred without sensible diminution. They build their nests in the grass and lay two or three eggs, white and about the size of a common goose's egg. They are web-footed, but are never seen in the water; indeed there is no water on the uplands, and their food is principally berries and a common *Sonchus*. The strawberries (*Fragaria chilensis*) were nearly out of season. Trees were comparatively small. The mamane, sandal-wood, *Dodonæa viscosa*, *Geranium cuneatum*, were the most common, and many compositæ with brilliant yellow blossoms (*Raillardia*, *Dubautia*, etc.) were seen all through the plain.

---

[7] Ellis, Tour of Hawaii, London edition.

[8] Height as obtained many years after this by the Hawaiian Survey is 8275 feet.

I made me a bed of bracken (*Pteris aquilina*) as I might in New England on a similar occasion, and with my feet towards a fire of great mamane logs, went to sleep. The night was clear and cold,—so cold that I awoke and moved nearer the fire. It was strangely silent; the stars were shining brightly, and directly in front of me was the grand Mauna Loa. At half-past three the moon rose over the slopes of Mauna Kea and I fell asleep again. In the morning at sunrise the thermometer marked 46° Fahr. As the sun rose, the lava-flow of 1859 was visible through its whole length from near the summit of Mauna Loa to the sea near Kawaihae, shining like a river of silver, owing to its glossy black surface. Could it have been more beautiful when a river of fire? All the plain between the mountains, which covers many square miles, is intersected by lava-flows from all three mountains, and is wholly rocky and uneven, with caves and beds of a-a. The vegetation is scanty, but enough to support large flocks of goats. A road was attempted by Government some years ago under the direction of Dr. Judd, from Kailua on the western coast of Hawaii to Hilo, but only fifteen miles of this road (which was not intended for wheeled vehicles) were built. Caves are the only sources of water here, the surface being too porous to retain pools or streams; but in the caves the water from the frequent rains drips from the roof and is collected in calabashes.

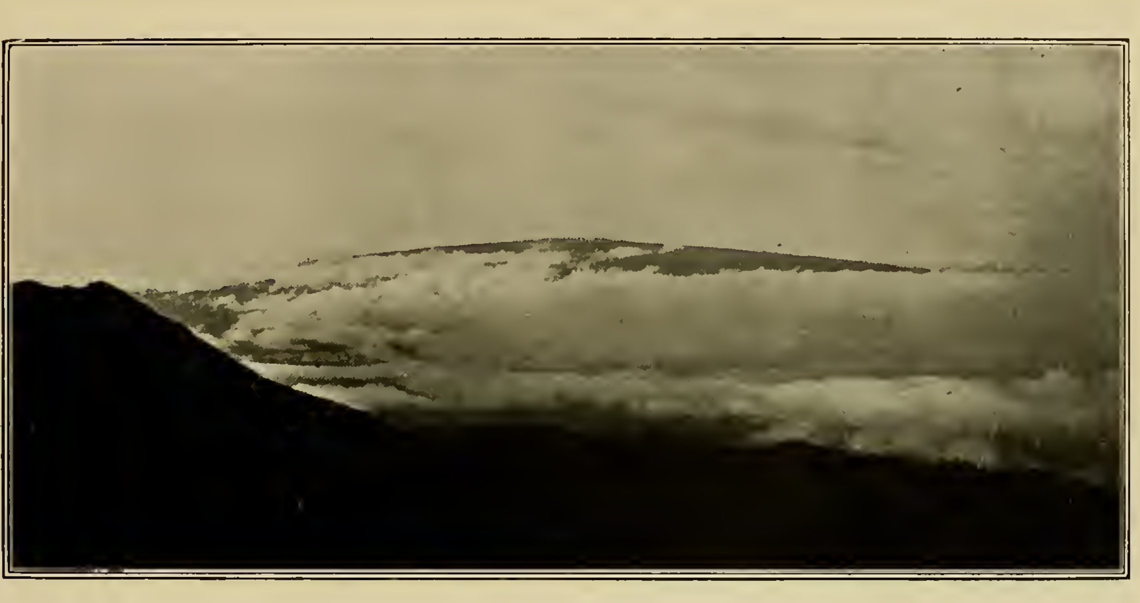


FIG. 11. MAUNA LOA FROM TOP OF HUALALAI.

Since this ascent I have been again to the summit of this mountain (in 1889) and found little change to note. The wild goats had disappeared and packs of wild dogs, little less dangerous than wolves to a solitary footman, had taken their range. Acres of an introduced purple thistle of a most luxuriant growth were found on our path some distance below the summit.

The only recorded eruption from this mountain took place in 1801, and was certainly not the one seen by Turnbull as has been stated; his record is, "On the evening of February 1, 1803, we stood along the shore [of Hawaii] to the eastward, taking the advantage of a land breeze. In this course we had a very full view of some eruptions from the volcanoes in the centre of the island of Owhyhee."[9]

The account of Ellis, taken from the lips of an Englishman and of natives, is as follows:

> Stone walls, trees, and houses all gave way before it, even large masses of rocks of hard ancient lava, when surrounded by the fiery stream, soon split into small fragments, and, falling into the burning mass, appeared to melt again, as borne by it down the mountain's side. Offerings were presented, and many hogs thrown alive into the stream to appease the anger of the gods, by whom they supposed it was directed, and to stay its devastating course. All seemed unavailing, until one day the king Kamehameha, went attended by a large retinue of chiefs and priests, and, as the most valuable offering he could make, cut off part of his own hair, which was always considered sacred, and threw it into the torrent. A day or two after, the lava ceased to flow. The gods, it was thought, were satisfied.

To this eruption is referred the sad story, often told to travelers by the natives, of the death of a mother and her infant. At the beginning of the century the base of Hualalai had many fishermen's hamlets along its shore. At night, while all were sleeping, the eruption began. The stream of lava came thundering down upon the people on the shore, and while nearly all succeeded in escaping, in one hut only the husband was awakened, and in his terror he fled leaving his wife and child. Before she was aroused by the shrieks of her friends, the lava had encircled the hut and escape was no longer possible. The lava set fire to the house, and the woman sprang into a pandanus tree near by, but her refuge was of short avail, and the lava-stream, which was flowing into the sea, consumed, as it passed, the two human sacrifices to Pele.

The remarkable rapidity with which this stream descended indicates great fluidity. It appears to have flowed fifteen miles in two or three hours, much of the way through forests. Its source was a little below the summit, and it issued in two streams, one to the northwest and the other to the northeast. Twenty-three years after this Ellis found a warm spring at Kailua where Glauber's salts were formed by the action of sulphurous vapors on sea water, and warm springs were also found at Kawaihae at tide level. These are now cooled and there are no signs of volcanic activity anywhere on the mountain. This latest effort of Hualalai, besides destroying several small villages, and filling up fish ponds, ended by changing the coast line for twenty miles from a bay to a headland several miles beyond the old coast. The streams which in former ages flowed at intervals down its sides do not appear to be of so great volume as those from Mauna Loa, and this may be owing to the great number of vents. Their physical structure, however, is identical with that of those from the other mountains.

---

[9] A Voyage round the World in the years 1800–1804 by John Turnbull. London, 1813. P. 144.

Continuing my description of the mountains before attempting the story of their eruptions, I will offer the account of my first ascent of Mauna Loa, made almost immediately after that of Hualalai.

FIG. 12. BREAKING CAMP ON THE INLAND BASE OF HUALALAI, 1889.

On Tuesday, August 2, we left the hospitable house of Rev. J. D. Paris, the missionary at Kaawaloa. The native magistrate, Kupake, had heard of our intended journey and sent us two large dried fish, a most acceptable present, and a large gourd water-bottle. We secured as guide Kaakakawai, an old goat hunter, and we had also three native bearers and a pack mule. For the first six or eight miles our road was the same as when we ascended Hualalai, and, as then, we got wet through in passing the forest, this time by a thunder storm of short duration. We camped at night on the mountain-plain near Judd's road, and in the morning sent back our horses and prepared our raw-hide sandals for climbing over the rough lava, as there is no path for horses up the *smooth* dome of Mauna Loa.[10] We went nearly east until we struck the flow of 1859, and then followed that up more than eight miles. The surface was black and shining and quite brittle, and as we walked over it, it sounded like a hard frozen crust of snow. The outer surface to the depth of nearly half an inch was very porous and readily separated from the harder interior. In many places the lava had flowed up hill, dammed up behind by its rapidly hardening crust; and it sometimes attained an elevation of twenty-five or thirty feet without breaking from its pipe. Bubbles of great size, some still perfect, others broken in, were very common, and in some of the caves thus formed ferns were growing in the moist atmosphere. On the surface cracks also we found a *Polypodium*, but lichens were rare. Here and there we came to a deep round hole, and by its side lay the bleaching tree that had been burned off. The clumps of shrubs often approached within twenty feet of the flow, but in other places they had been killed to a distance of fifty feet, probably by gases, as they were not at all charred.

---

[10] As will be seen later, fair trails are now known up both sides of Mauna Loa.

Immense beds of a-a with almost perpendicular sides, crossed our way, sometimes at the edge, sometimes directly across the flow, but always more or less level on top. The roughness of this a-a was greater than any we had met before; and we needed the raw-hide sandals we had prepared for such places, as well as thick buckskin gloves to protect our hands from the sharp needle-like points. Often the deep canal which the fiery river had made for itself, was visible through large breaks in the covering crust, and on approaching a hole of this nature I found myself on the verge of a gulf a hundred feet deep, of unknown length, and, as nearly as I could see, two hundred feet wide. The bottom was rough and cracked, and mainly covered with the fragments from the roof and sides, fallen since the lava had ceased to flow. The crust on which I stood was but a few inches thick, and although I had tested it with my staff before, I thought it safest to lie down and crawl until I had got several rods from the hole, and I did not venture near another.

The roughness of the flow at last turned us aside to the right on to the old pahoehoe which is covered thinly with grass and small bushes along the numerous cracks. Mauna Loa remained clear all day, and the summit did not seem very far off. Indeed at seven o'clock in the evening when we decided to camp for the night, had it not been that we were still within the limit of vegetation, I should have been inclined to push on and reach the summit that night. The whole surface of the mountain is undulating, and as we reached what seemed to be the top, we found a shallow valley and another hill beyond, and so it was all the way. We got the most sheltered place we could find, as we had no tent, and there were not enough bushes to make a hut; Kaakakawai shot a goat, and we ate our supper. The wind was quite cold, and we were not warm enough to sleep well, and while we were awake we saw a most novel sight,—what I may call an inverted sunset. The clouds had risen rapidly until they quite covered the plain and dashed their misty van against the base of the three giants, quite cutting them off from the rest of the world except Haleakala on Maui which towered above the mist. The surface of the clouds was rough and in constant motion, and as the sun sank into it, it seemed to kindle into flames of the most brilliant colors. All the golden canopy we usually see above the setting sun, was below it here, and above, all was clear. The clouds swept up nearly eight thousand feet, but no higher, and we were soon asleep above their limits.

The morning was clear and not very cold, and the view of Hualalai and Kea was very grand. At seven o'clock we had eaten our morning meal, put out our fire, and started on our way. The craters of 1859 were just on our left as we went up, and for two miles the crevices were filled with the *limu* or basaltic pumice, which is green and very light, and with Pele's hair. This fine volcanic glass was blown more than sixty miles during this eruption. At three o'clock two of our kanakas gave out, and we were obliged to leave them, assuming their burdens ourselves. The others were sick, and bound their heads up with leaves, complaining that their heads and stomachs were affected, imputing it all to the wind, which, however, was very light. Mr. Mann and myself felt no inconvenience from the altitude during the journey.

At night we were about half a mile from the terminal crater, and we found a long narrow cave, once the bed of a small lava stream, and still horrid with projecting points. It was five feet wide, two feet high, and of considerable length. We slept in Indian file, or rather tried to sleep; our bed was a magnified rasp, and although we broke off as many of the teeth as we could, more than enough remained. We needed all our blankets to protect us from the severe cold which froze water solid in the cave at our feet, but we had to push a fold beneath every time we turned. I got up before sunrise, and the air seemed intensely cold; I ran to a little hill and saw the sun come up through the clouds, and then crawled into the cave again and breakfasted. We then covered ourselves well with blankets, and walked up to the crater. Mokuaweoweo is the most perfectly formed crater on the Islands although not the largest. The walls almost a thousand feet high, are nearly perpendicular and unbroken for much of the circuit. When the United States Exploring Expedition ascended Mauna Loa in 1841, the bottom was rough, and contained eight or ten cones, some of considerable height; now there were only two cones, about two hundred feet high each, near the eastern wall; the whole bottom had been overflowed with fresh black lava, and as examined with a powerful glass was no rougher than an ordinary lava-stream. We were on the highest wall, 13,675 feet above the sea, and on the opposite side from the Wilkes encampment. On a small pile of stones was a sandal with the inscribed names, Paris, Alexander, Haskell, 1859. The sandal looked new and fresh as if just cut from the hide. I was told that a cow once strayed up here in search of water, and died, and her body was found dried and retaining its shape completely.

The hard compact gray stone of the walls is much cracked and exhibits deep strata as elsewhere. Scattered along the edges, and in various places over the great summit plain were large irregular masses of a solid reddish clinkstone of a sort much used formerly for stone adzes. Several immense cracks parallel with the crater walls extended some distance. These sometimes contained ice; and on breaking the surface, which was some two inches thick, we found a large supply of fine water in the ice, with which we replenished our water-bottles. No snow was visible, and it is a mistake to suppose these summits within the limits of perpetual snow, as has been stated. Seldom in the summer is any snow found here except in the caves where it is preserved as in ice-houses. Snow sometimes falls on both Mauna Loa and Mauna Kea, but, except in winter, it disappears as soon as the sun rises.

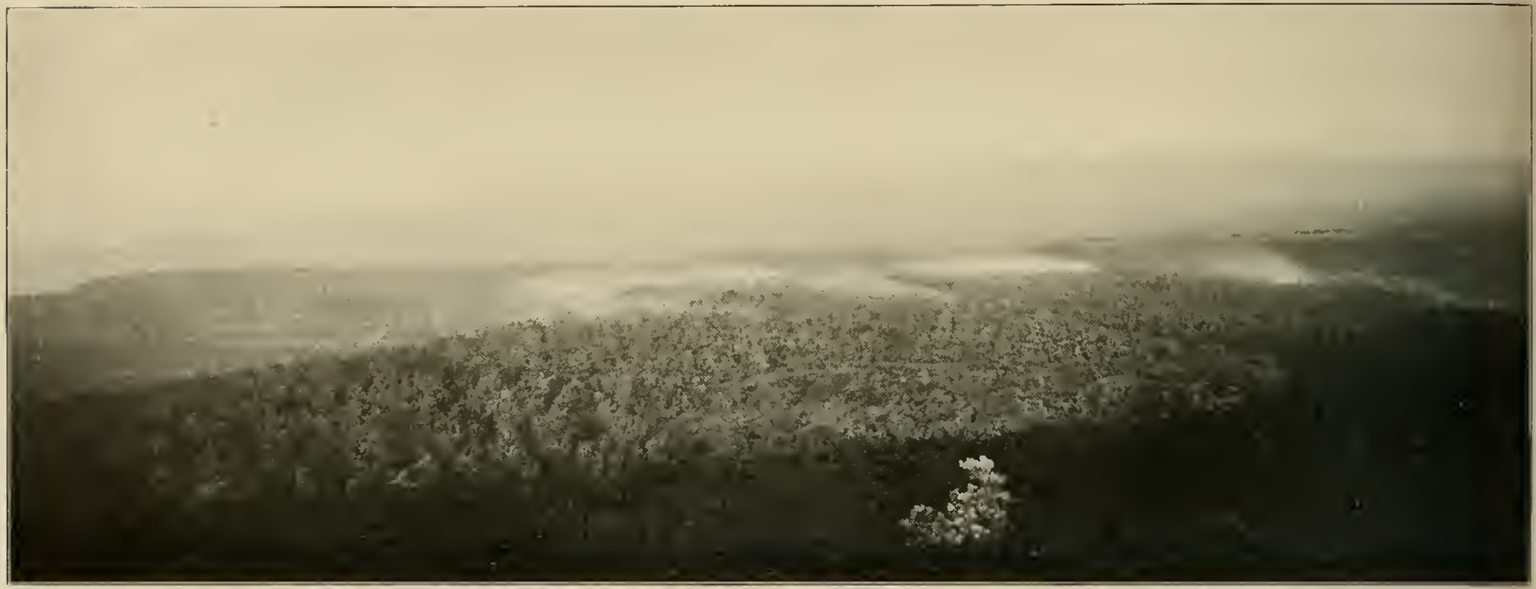


FIG. 13. MAUNA LOA FROM KILAUEA AT 7 A.M.

At first we did not see any signs of volcanic activity, but at last discovered steam issuing from the northern bank. Mr. Mann advised a descent into the crater and we attempted it, but after climbing down more than half way gave it up. Adjoining Mokuaweoweo are two small pit craters on the major axis of the elliptical main crater, and into the southern one a stream of lava has flowed from the main crater. The summit plain is much fissured, and several small cones both north and south, but on the same general line, mark eruptive agencies. So extensive is this plain that one walks nearly a mile before catching sight of the ocean, consequently no one at the sea level has ever seen the top about the crater, and when fire is seen at the summit, it means that the rising column of lava must attain a height of considerably over a thousand feet to be visible from the shore. At nine o'clock we commenced the descent as our time was limited, and about two in the afternoon a thick misty rain came on, and our guide wished to stop as he could not see the way; we had, however, three compasses, and proceeded without difficulty, although drenched, to the plain, where we found a cave and contrived to light a fire. At nine o'clock the rain ceased, the stars came out brightly, and as the cave still dripped, we rolled ourselves up in our blankets, wet through as we were, and with our feet to the fire slept well all night. In the morning we wrung out our clothes, which dried in the course of two hours as we were walking rapidly in the sun, and about noon rested on the edge of the forest, several miles west of where we had come up, at a spring which, as they always are on this island, was in a very improbable place,—the most elevated part of an open plain. Its position was marked by a pile of stones; no stream ran from it, and it was carefully covered to keep the wild hogs out, whose marks we saw near by among the strawberries and on the trees. Striking into the woods we walked down at a rapid rate, although the muddiness of the path, and the many trees that had fallen across the way, made it very laborious. Added to this, it began to rain as we came into the region of ferns, and we were again wet through. Vegetation on the leeward side of Mauna Loa only extends to the height of six or seven thousand feet, but on the windward slopes to nearly ten thousand.

It is not difficult to obtain the average slope of this mountain, but seen from Kilauea the slopes to the southwest and to the northeast vary perceptibly, but the angle of 7° is the average, and explains the name *Las Mesas* given by the Spanish discoverers of the group, also the "Long Mountain." (See Fig. 13.)

In 1880 I made the ascent of Mauna Loa from the eastern side accompanied only by an excellent guide, but mounted on an admirable mule. We came to the dairy at Ainapo in the afternoon, and after a short halt, pushed on to the limit of vegetation where there was still grass for our animals, and rested for the night. Our view of Kilauea was almost a bird's eye one, and the appearance was of a great city in flames. The crags about Halemaumau seemed the ruins of burning structures, and it was not until sheer weariness closed my eyes that I could look at anything else (Fig. 14). By three o'clock in the morning we were on our upward way, and early in the morning halted near the brink of the crater a little south of the Wilkes camp, to which the officers of the American expedition with a large company of native bearers had climbed forty years before with so much trouble. My object was to see the traces of an eruption in Mokuaweoweo, the summit crater which, appearing in the spring of that year, had induced me to again visit Hawaii. All the way up the temperature of the caves had been considerably above that of the outer air, but on the summit there were only the cold lavas of the May eruption. Much limu or basaltic pumice covered the plain for acres, and the wall of the crater was very loose and insecure where we stood.

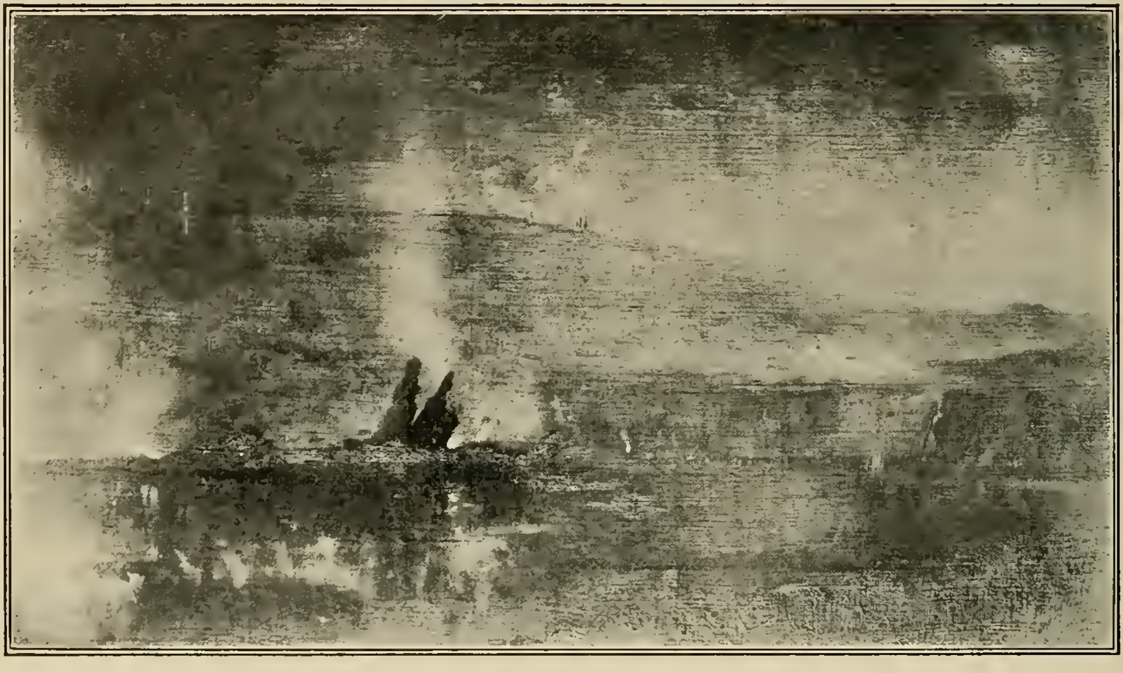


FIG. 14. HALEMAUMAU IN 1888. FURNEAUX.

We returned by the same trail, if trail there was, it was invisible to me, but my guide never hesitated, neither did the mule, and we returned safely to Ainapo before dark, and were at the Volcano House at Kilauea next day in the early forenoon. For some distance above Ainapo the way led through a dry open forest, with many dead koa trees, and little sub-vegetation owing to the herds of cattle pastured there; when once beyond this forest, the vegetation faded rapidly and the surface assumed the roughness of the ordinary lava stream, and was undulating as on the other side, and only here and there smooth for a short distance. Cracks often crossed our trail, and sometimes were

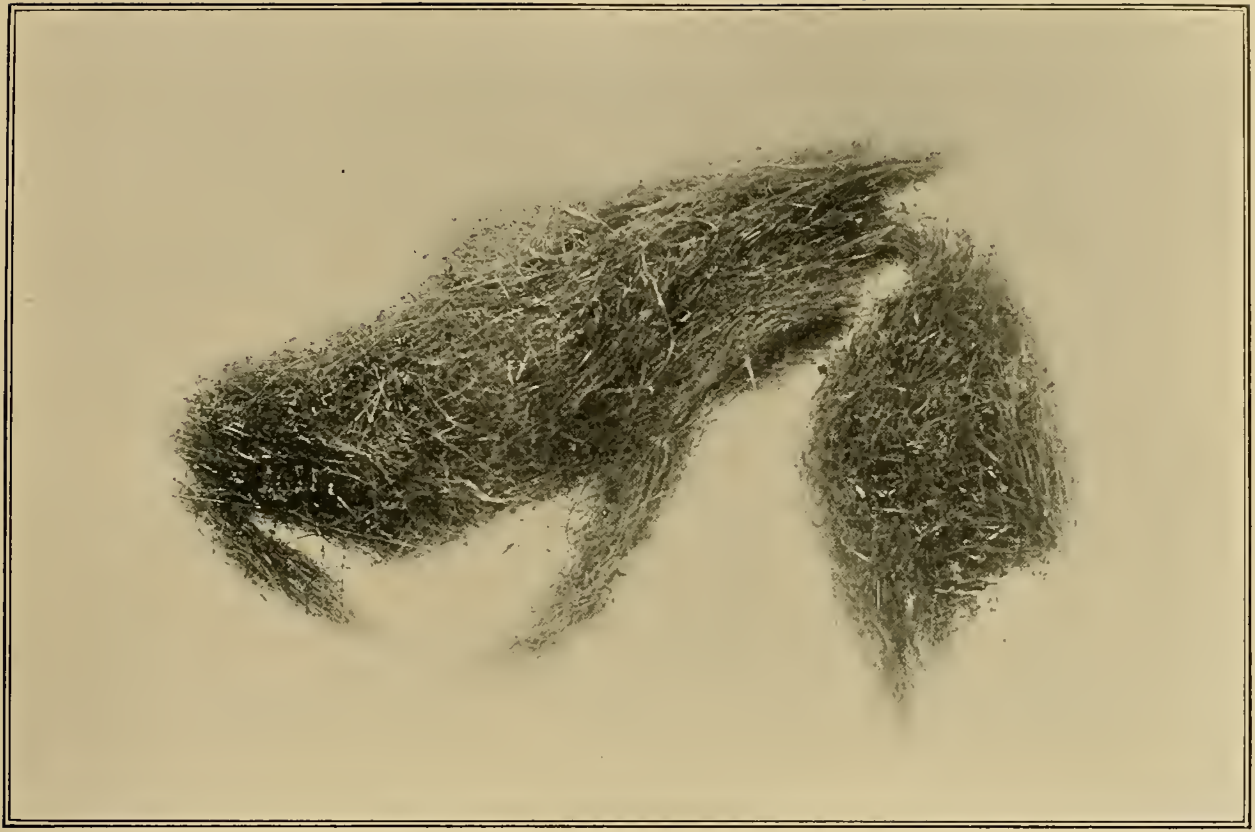


FIG. 15. PELE'S HAIR FROM KILAUEA.

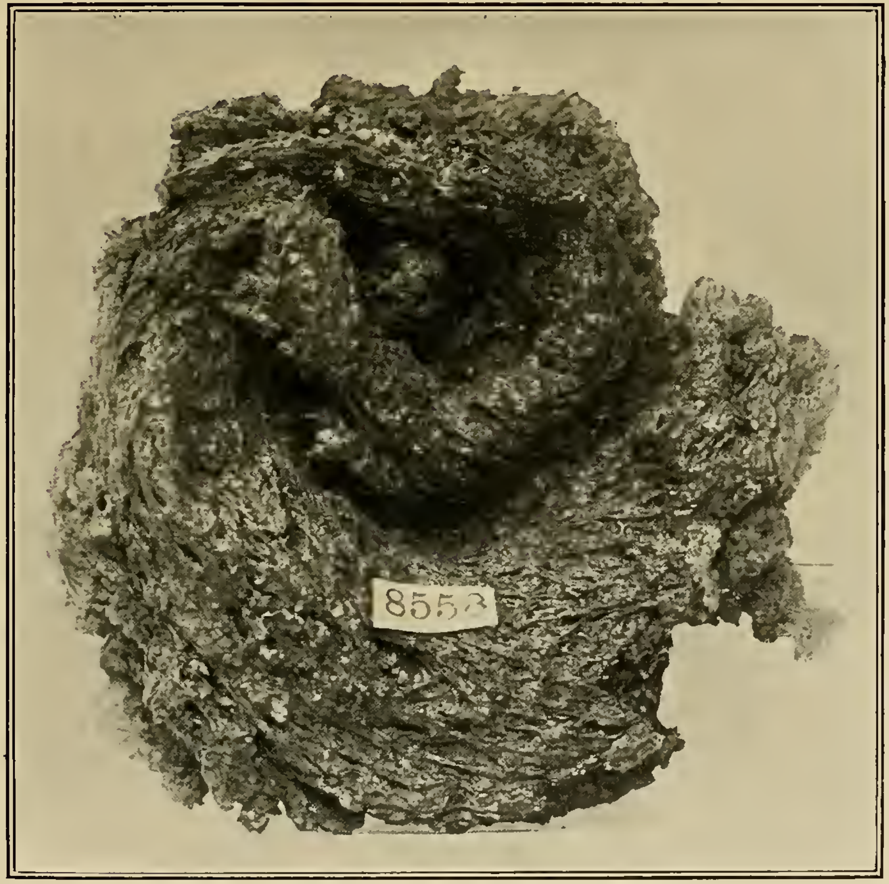


FIG. 16. FORM OF LESS FUSIBLE LAVA.

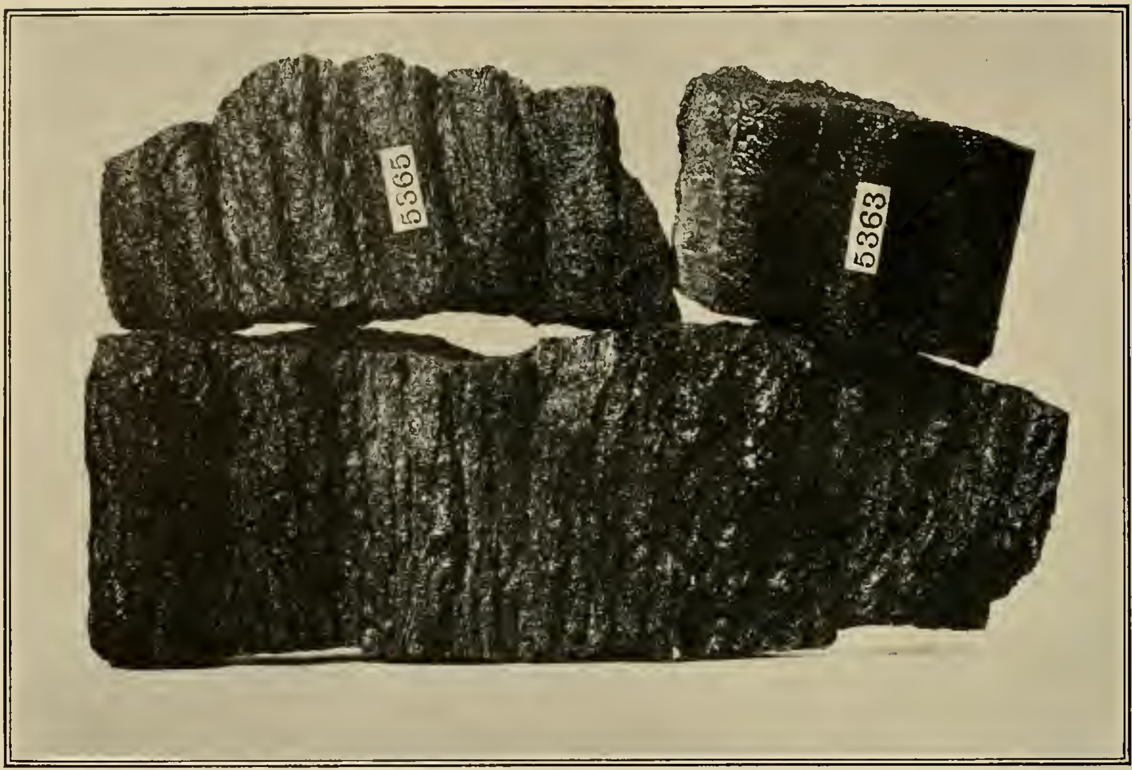


FIG. 17. ROPE LAVA.

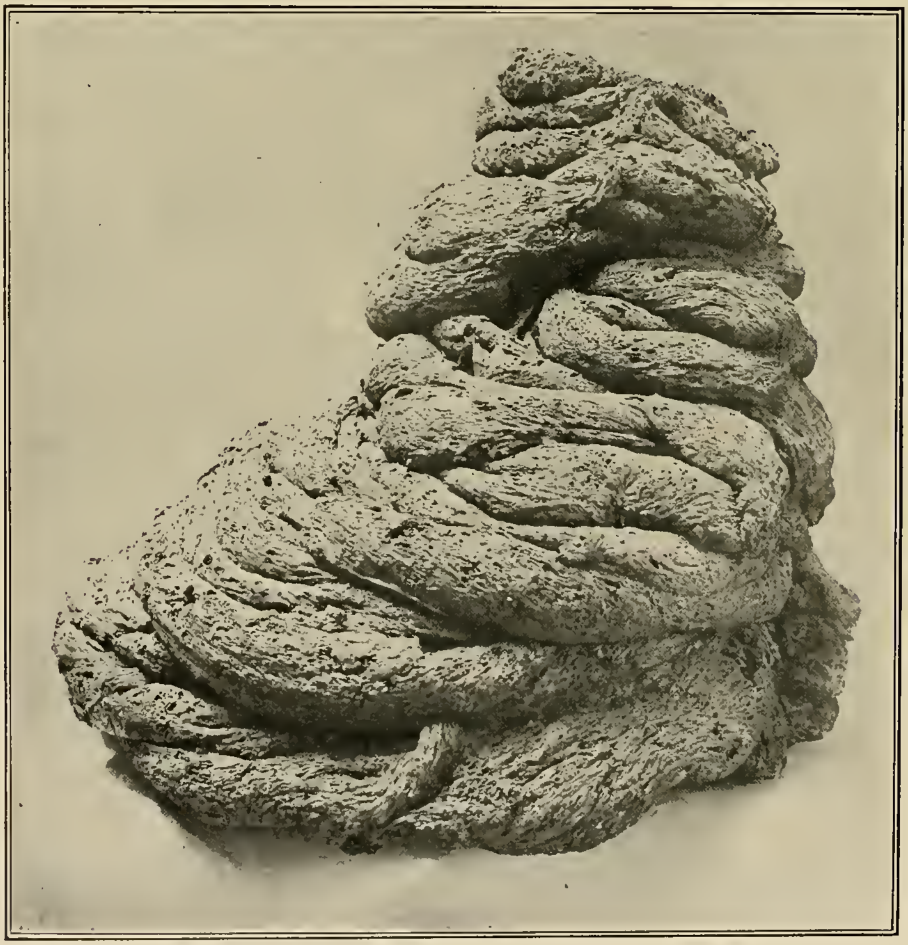


FIG. 18. DRIBLET UNDER LAVA FALL.

bridged for the mule by lava slabs and fragments, a shaky structure, and I was always glad when they were not too wide for my agile animal to leap. Fortunately we had no fogs, and no symptoms of mountain sickness. I felt, however, that if a storm had overtaken us, we should have had little chance of holding to our trail; a light fall of snow would have concealed it."[11] More important ascents we will record later.

General Character of the Lavas of Hawaii.

I DO not intend to enter fully into the many analyses of the products of the Hawaiian volcanoes, but simply sketch the coarser composition and the external appearance of the lavas, that my reader who is not familiar with these volcanoes may better understand the descriptions that follow of the activities of the volcanoes and the ejected material met with in crater or lava-stream.

Of the two general classes into which geologists have divided lavas, the acid or trachytic,—Trachyte, Obsidian, Pumice, Granite,—and the basic of which Basalt or Dolerite is the type, we have on Hawaii only the latter class. Basalt contains a feldspar having more lime than soda, augite, sometimes in well defined crystals, chrysolite or olivine in green nodules, often agglomerated, but generally diffused through the mass, and almost invisible to the naked eye. Magnetite is also present, and rarely Mica. Silica, Iron, Soda, and Lime are the final constituents.

When the ordinary lava is thrown into the air as in the tremendous fountains that often accompany the eruptions of Mauna Loa, drops are thrown off, and, caught on the currents of hot air, spin out a glassy filament sometimes exceeding three feet in length. These glassy threads are locally called "Pele's hair" (Fig. 15), and in the crater of Kilauea, as also wherever jets of lava are thrown up, they are constantly forming during the ordinary active condition. When the lava cools rapidly, as in these threads, the structure is glassy: when the cooling is slow the texture is stony: this is well shown in the impression of an actual specimen of rope-lava shown in Fig. 19. The outside is compact, while as we pass to the interior the cells grow larger and the magma is stone-like. The less fusible portion of the lava often separates in a rough form (Fig. 16); the more fusible, like Pele's hair, retains its ductility in a surprising manner until the high temperature of the air in which it is formed is considered. Lengths of three or four feet have been found spun from the fountains of lava on the slopes of Mauna Loa during an eruption. The plasticity of the molten lava is well shown in Fig. 23, of a curious vase wrought from the molten lava of Halemaumau with no better tools than round and charred sticks. The cooling surface of the pahoehoe still in motion wrinkles in the ways shown in many of the plates of this memoir, and the wrinkles often become twisted into fine rope-like forms (Fig. 17), with a very black and shining surface.

---

[11] A fuller account of this ascent was published in the American Journal of Science in 1888, and this will be inserted later with the accounts of the eruption of that year (1880-81).

Of the stony lavas there are many varieties, from the compact phonolite or clinkstone which takes a good polish, and from the hardest varieties of which the old Hawaiians made their adzes and other stone tools, to the very cellular form shown in Fig. 21, a hard form often used for building, and the strangely elongated cells of specimens found near the shore east of Hilo (Fig. 22). The more compact kinds used for building show almost no cells, while that from the surface quarries is more or less cellular, and often well sprinkled with olivine which impairs its value as a building stone. Even the fairly compact rocks are quite permeable to water, making excellent filters, and the apparently smooth and non-porous pahoehoe gives passage to rains as may be seen in the mountain caves. Basalt is more apt than other lavas to assume the prismatic form on cooling, and many contraction specimens can be found in the gorge of the Wailuku above Hilo (Fig. 25), and more perfectly detached ones are found on Kauai.

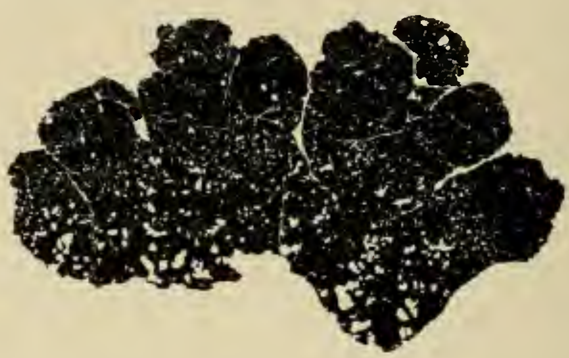


FIG. 19. IMPRESSION OF A SECTION OF ROPE LAVA.

We must not forget the ductility shown in the lava falls, examples of which are shown in many illustrations. In the eruption of 1832 in Kilauea a fall of nearly 200 feet was continuous: a portion of this fall is shown in Plate XLVI. A driblet from another fall is shown in Fig. 18.

When, by violent explosions as in the eruption of Kilauea in 1789, the lava is torn to pieces or ground into sand, a material is formed that under the influence of moisture tends to recombine into a volcanic sandstone called tufa, but this reunion of particles is usually, if not always, accompanied by a rearrangement of composition which may be decomposition or metamorphism. Tufa is not common on Hawaii, but abundant on Oahu, where the coast craters, Diamond Head, Punchbowl and others are composed of it. In the quarry on Punchbowl a tolerably firm tufa has been employed for building purposes, but has not proved durable. The sand may be mixed with

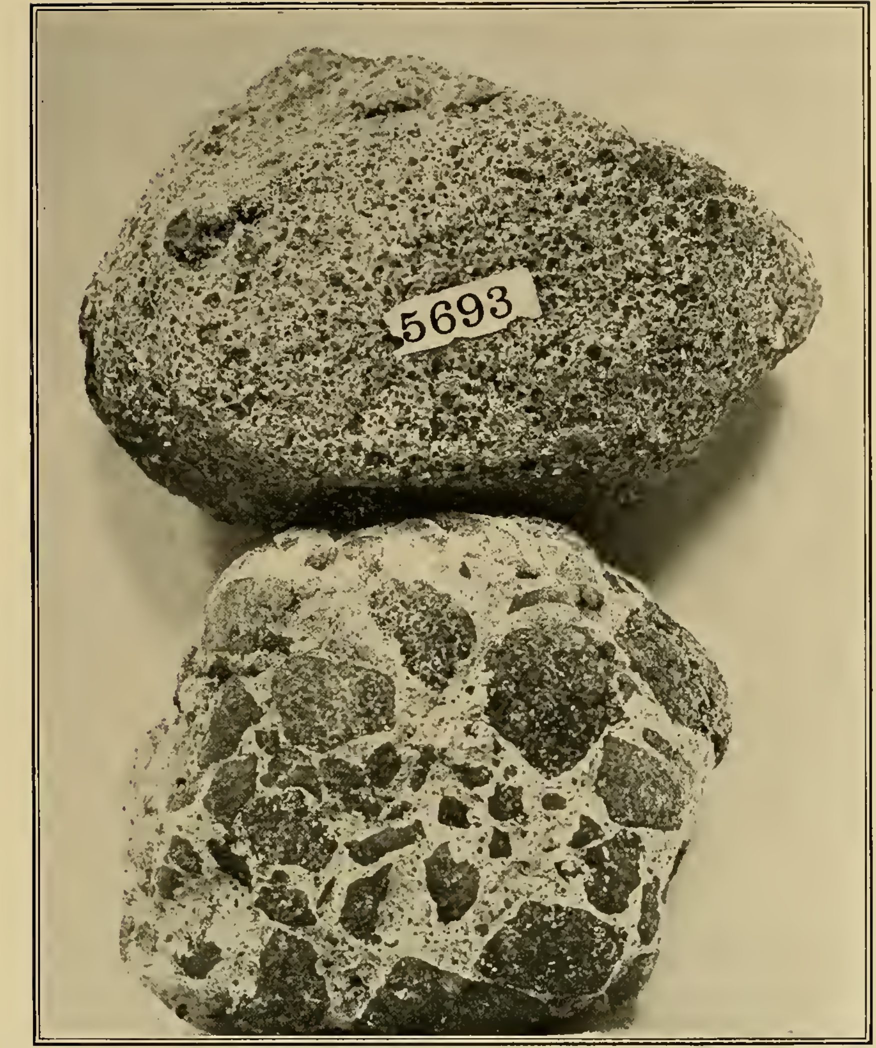
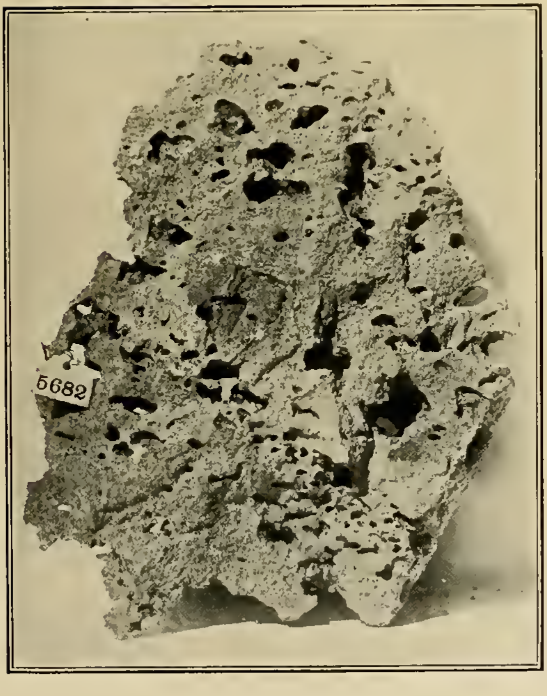


FIG. 20. PALAGMITE FROM DIAMOND HEAD.



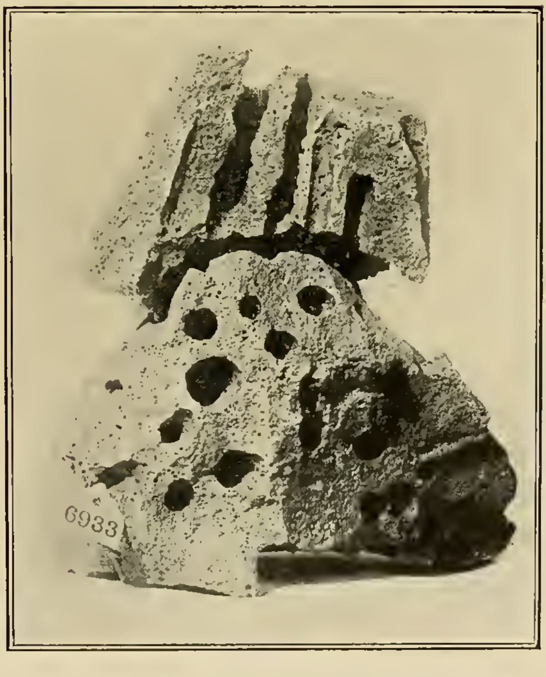


FIG. 21. STONY CELLULAR LAVA.

FIG. 22. LAVA WITH CYLINDRICAL CELLS.

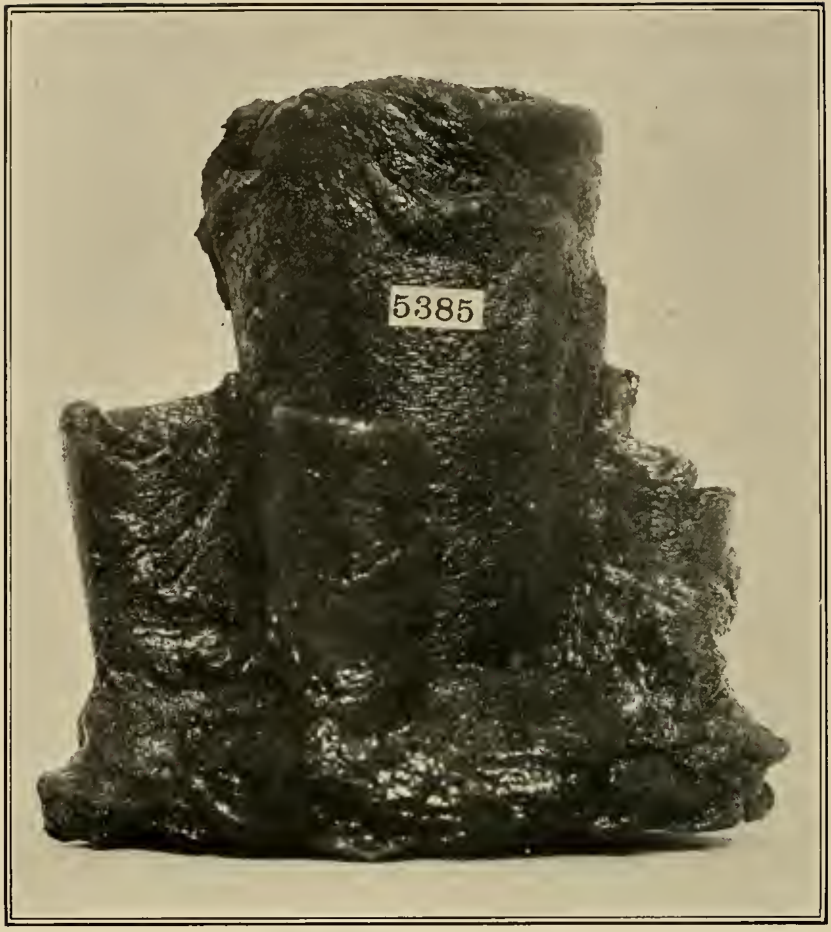


FIG. 23. VASE MADE FROM MOLTEN LAVA.

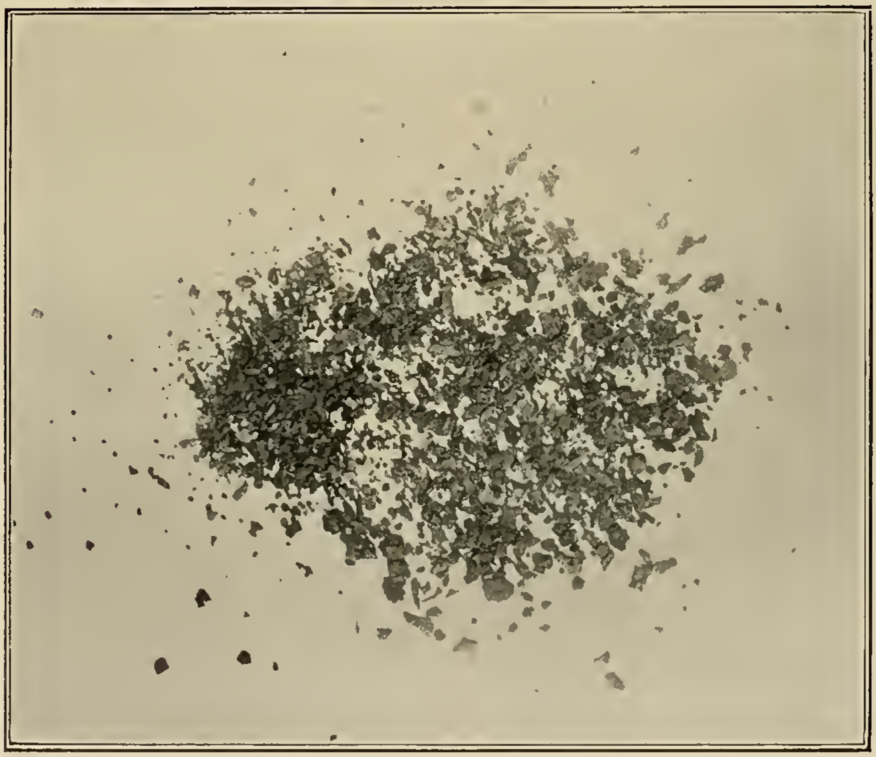


FIG. 24. BLACK VOLCANIC SAND.

larger fragments of rock or with fragments of coral reef and shells as in the case of Diamond Head, which exploded through the reef (Fig. 20), forming a coarser conglomerate. The varying color, brown to red, comes from the decomposition of the hydrous ferrous oxide ($Fe_2O_3+Aq.$). The coarser black sand (Fig. 24) is formed by the forcible contact of molten lava with water, as at Nanawale when the lava stream of 1840 fell into the sea.

Scoria, a term originally applied to the slag or dross of metals, has been rather loosely applied to all the odds and ends of a lava discharge, from a-a to cinders. The finer scoriæ or cinders are the constituents of cinder cones like those on Mauna Kea, which hold together chiefly by the cohesion of the rough surface of the cinders. The black sand (Fig. 24) is found in layers under Honolulu and elsewhere, and is much used in building operations.

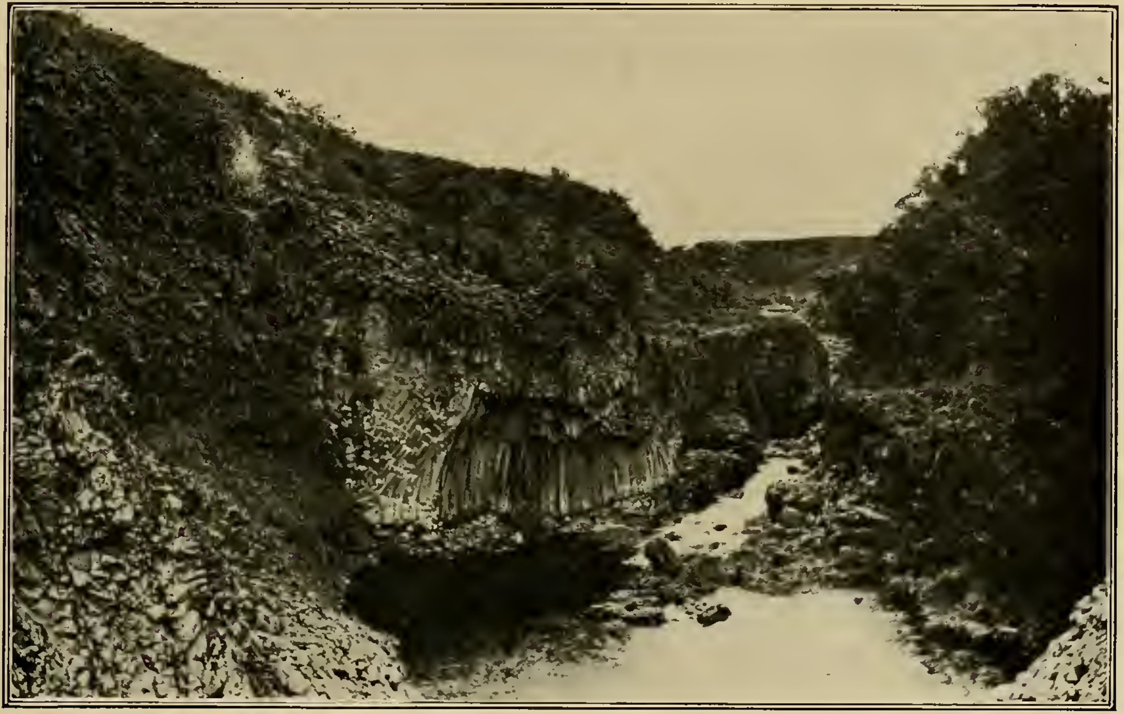


FIG. 25. BASALTIC PRISMS IN WAILUKU GORGE.

The vapors or gases emitted from the craters of the volcanoes when active are never true smoke, but mainly steam. In the crater of Kilauea a distinction must be made between the vapors from Halemaumau and those arising from the outer crater: the latter being the rain products either directly, as after a shower, or from the more lasting surface springs. It is remarkable how permanent some of the steam-holes around Kilauea are. I have observed some of the more prominent ones, as those near

Keanakakoi, for forty-five years and have seen little change.[12] The cloud which often, but not always hangs over the active pit is the steam condensed by the cold winds from Mauna Loa ten thousand feet above it, and as steam has been thought the main factor in the rise of lava in the craters, it should be noticed how small the supply of steam in the active outpour of Kilauea really is. While the heat would of course render the aqueous vapor invisible directly in or over the pit, that very heat drives the steam up into the cold regions, and it would be seen as cloud, or pour down as rain if abundant, but neither effect is always produced at times of greatest activity, and when the pit is empty of molten lava the smoke is often most abundant (Fig. 26). Next to steam sulphurous acid (H_2SO_3) is abundant, and so far as my experience goes is always present: this dry vapor is pungent and in passing through a stream of it one must hold his breath. This gas is often so abundant as to prevent travel around the lee side of the pit, sometimes even of the main crater. Hydrogen, supposed to be the result of the decomposition of water by great heat, is often present and its combustion is seen in the flames that play around the cracks or, as in 1880, rise in considerable

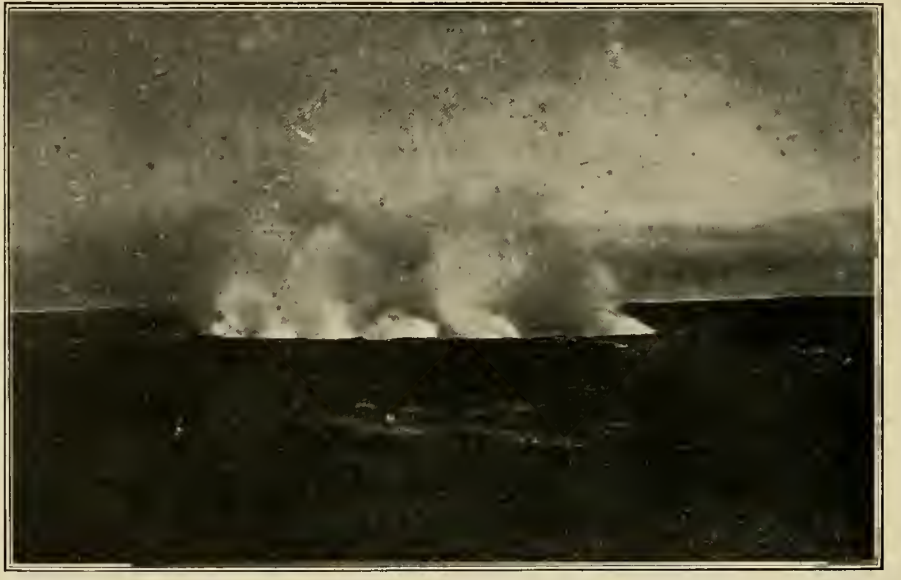


FIG. 26. KILAUEA WITH SO-CALLED SMOKE FROM HALEMAUMAU.

---

[12] The late Wm. Lowthian Green in his valuable "Vestiges of the Molten Globe," II, p. 75, writes: "It has sometimes been said that the large quantities of *pure aqueous vapor* often noticed in and about Kilauea, shows that it is steam, or the vapor of water, which produces the appearance of 'ebulition' in the lava lakes. We venture to suggest that any vapor of water which had been intimately mixed or 'boiled up' with the white-hot molten lavas of the Kilauea lakes, could never again appear at the surface as pure steam. It would be partially decomposed, and unmistakably tainted with sulphuretted hydrogen. Even the moist air which escapes would be so tainted. There is an evident source for all the pure steam found about Kilauea in the rain and the surface waters that get to the hot rocks: but they must be less hot than incandescent: or else the proportion of water to molten lava must be sufficiently great to reduce the temperature below a full red heat."

volume from blow-holes on the edge of the active pit. Carbonic acid, which is common where volcanoes break through calcareous substrata, as in France and Italy, is rare on Hawaii; so is chlorine and its compound with hydrogen, (HCl) hydrochloric acid: which would seem to show that sea-water does not often break through the island walls to the molten interior.

Minerals are uncommon in and around the Hawaiian volcanoes, but salts formed by the union of escaping gases with the elements in the lava are common as incrustations in the crater caves or under the crust of the floor, such as gypsum, alum, glauber salt, etc. Augite in fine crystals, olivine in nodules of some size, mica in minute hexagonal plates, quartz in small crystals, and rarely *en masse*, are the more common minerals. The gases convert the rocks into soil far more rapidly than the frosts of colder climates. The sulphides of iron, pyrite and marcasite which have been considered the source of the sulphurous vapors abounding in the crater when active, must be almost entirely decomposed for they are seldom found in the cold lava: natives have brought me the former in small specimens thinking it gold, but I have myself only once found it in Kilauea. The ferrous oxides are common, both red and yellow, and were well known to the old Hawaiians as a source of paint for their canoes, and coloring for their kapas. They are often found in the lava streams as lumps or rounded masses as if rolled, seldom as deposits, except in swamps as limonite.

Stalactites and Stalagmites.—There is a curious formation, at times common in the caves that exist beneath the floor of Kilauea crater, and not infrequent in similar caves in dead streams of lava on the mountain slopes. At first glance the small grey rods that hang from the roof, and the curiously modeled droppings beneath these, seem to be of igneous origin, or droppings of melted lava from the roof. An examination *in situ* shows that this is not the case. The roof of these caves averages two feet thick, and where the stalactites occur is unbroken. On removing the tubes with care one finds no visible crack, and there is generally no fresh molten lava on the upper surface. The formative process may be clearly seen as the tubes grow from day to day. Professor Dana, after quoting my account in his "Characteristics of Volcanoes,"[13] could hardly believe the rapidity of the process, but observations repeated more than once during the last forty years only confirm my early description, which I here repeat. I have caught the steel-grey deposit in the drops on the end of the tubes upon my finger and watched its solidification. Usually the tubes are straight cylinders, from one to three-eighths of an inch in diameter, and somtimes more than two feet long. As any sharp earthquake would at once break such long rods from the

---

[13] Dana, Characteristics of Volcanoes, p. 341.

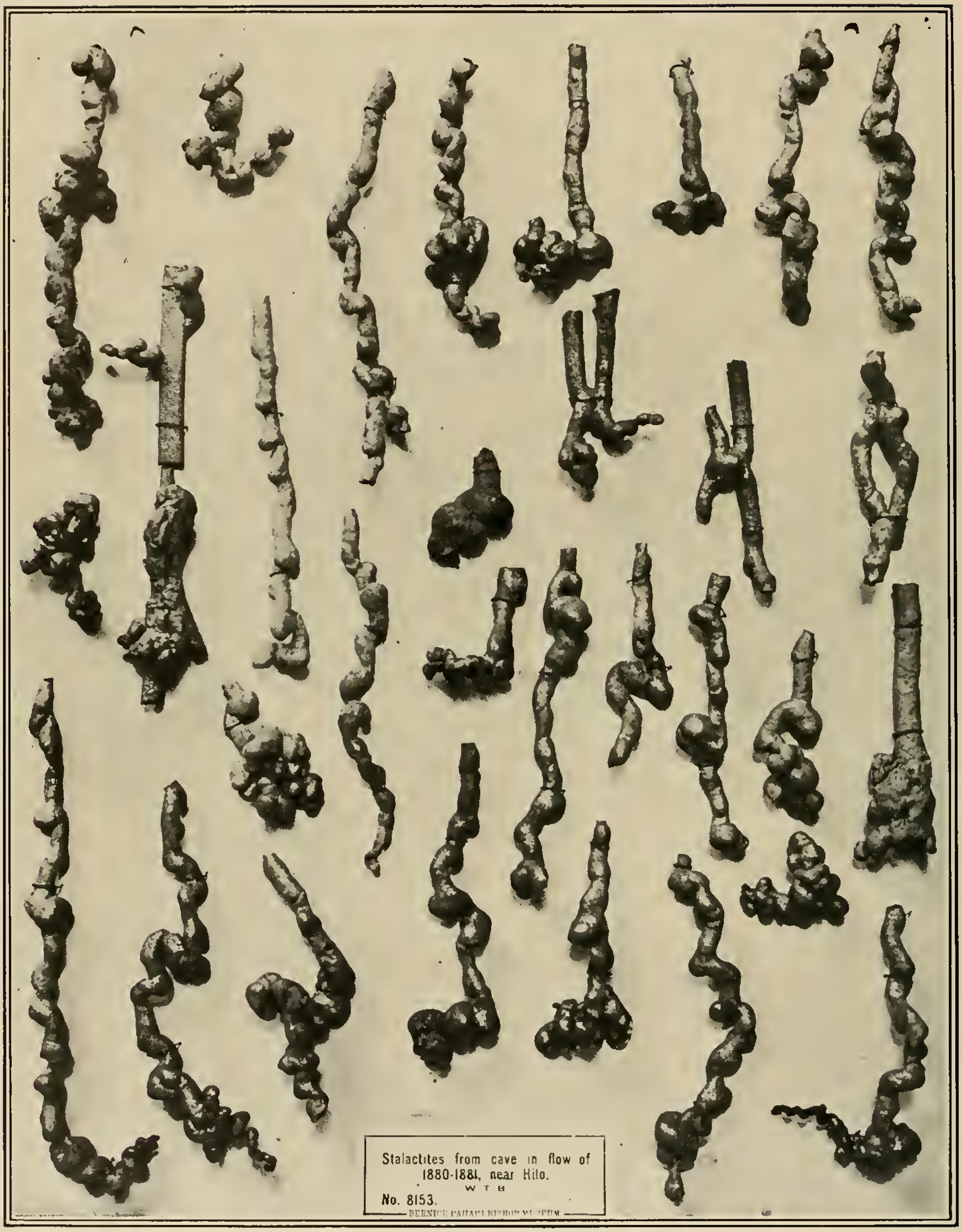

Stalactites from cave in flow of 1880-1881, near Hilo.
W T B
No. 8153.
BERNICE PAUAHI BISHOP MUSEUM

FIG. 27.

roof they must grow with rapidity to attain such length between the frequent jars. The bore is almost never continuous, and while externally they are smooth (with a minute crystalline marking), within, a mass of stony cells often nearly occupying the diameter of the tube is presented. As long as these tubes grow downward in the quiet upper region of the cave they hang perpendicularly, but when they reach farther down the currents of air and steam blow the drop with the deposits aside and the tube becomes distorted: it may even return on itself. Many of the resulting forms are shown on the opposite page. This collection was obtained from a low cave in the flow of 1881 near Hilo, and as there were many breaks through the roof the currents of air were strong and irregular. There was no steam, but plenty of moisture when I visited the cave, and there was no active growth. In one cave in Kilauea in 1865 the growth of the stalactite was at about the rate of an inch a week, but owing to the varying amount of water or steam the production is quite

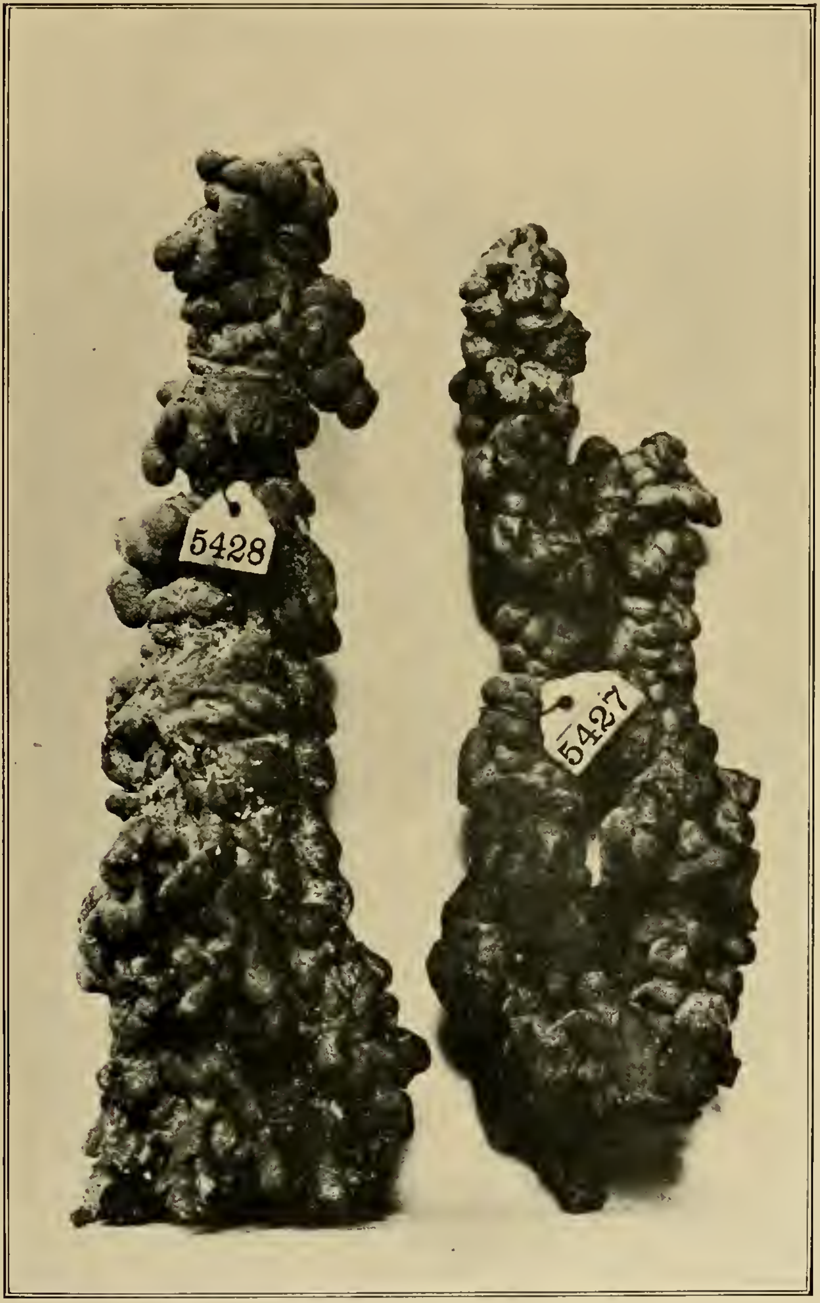


FIG. 28. STALAGMITES FROM A CAVE IN KILAUEA.

irregular. They are sometimes coated with beautiful white crystals of gypsum, sometimes tipped with needle-like transparent crystals of the same mineral, where the cave is high. The natives collect them with the upper open joint of a long bambu. The drip on the floor of the cave forms much thicker and more irregular stalagmites, as may be seen in Plates XLVIII and XLIX. Specimens have been found which exceed eight inches in diameter, and these are usually low and flat-topped. The more slender ones sometimes rise to a height of two feet; and so rapidly is the silica deposited, that they seldom increase in diameter, but are true *acrogens*, none of the suspended silica running down the sides. Fig. 28. The process of formation is this: the water from the frequent rains, and the condensing steam, act upon the soluble portions of the superincumbent rock, carrying along the silica and lime to be deposited in the form of tubes and their incrusting gypsum, and the resulting stone is quite anhydrous, as will be seen from the following analysis of specimens not coated with gypsum:[14]

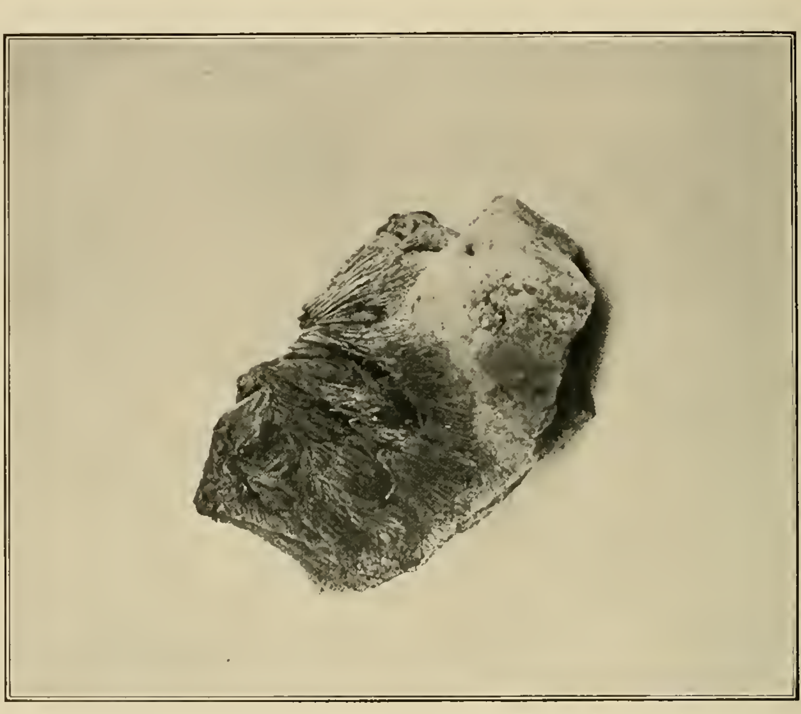


FIG. 29. BLOW-HOLE SPECIMEN.

SiO_3	Al_2O_3	Fe_2O_3	MnO	$Ca O$	MgO	Na_2O	K_2O	
51.9	13.4	15.5	0.8	9.6	4.8	3.0	1.1	= 100.1

Specific gravity, 2.9. The temperature of the caves is usually from 80°–95° Fahr. Other specimens examined by Prof. Dana had a hardness of 5–5.25, and a specific gravity of 1.656.[15] The imitative forms arising from the evaporation of the siliceous solutions in the caves are often quite curious, some resembling bunches of raisins, from a partial collapse of the incrusting bubble. The structure of all is stony and very cellular. The microscopic structure is clearly described by Dana in the volume referred to.

---

[14] Analyzed by Mr. John C. Jackson in the laboratory of Dr. C. T. Jackson, Boston.

[15] Geology of the United States Exploring Expedition, p. 201.

Before leaving the brief account of the common external forms of lava, it may be of interest to the reader to have before him some of the analyses of the Hawaiian lavas as given in my former essay on the Hawaiian volcanoes, and in more recent publications:

	A	B	C	D	E	F	G	H	I	K
	G=2.7					G=2.97	G=3.01	G=2.80	G=2.75	G=2.66
SiO_2	49.0	49.2	51.19	39.74	50.00	49.20	48.82	48.60	53.81	50.82
TiO_2						1.72	1.16		2.01	undet.
Al_2O_3	13.0	7.8		10.55	6.16	14.90	15.22	25.45	13.48	9.14
Fe_2O_3		13.7				4.51	5.72	17.55	3.02	7.33
FeO	15.0		30.26	22.29	28.72	12.75	9.65	1.20	7.39	7.03
MnO	7.8	13.0				0.28	0.67	tr.	tr.	0.38
CaO	8.9	8.4		2.74	7.40	9.20	10.40	2.20	10.34	11.63
MgO	0.4	5.1	18.16	2.40	2.00	3.90	4.55	0.98	6.46	7.22
Na_2O	4.5	1.8		21.62		1.96	2.10	1.38	3.23	1.02
K_2O	2.3	trace			6.00	0.95	0.90		0.64	3.06
P_2O_5						0.42	tr.	tr.		
H_2O		0.5		.33		0.10		1.87	0.57	1.74
	100.9	99.5	99.61	99.67	100.28	99.89	99.19	99.23	100.95	99.37

Of these analyses A was of dark bottle-green lava drops from Halemaumau. Dr. C. T. Jackson.

B. Pele's hair, Kilauea, 1864. Both protoxide and peroxide of iron were present, but owing to the presence of oxide of manganese the proportions were not determined. J. C. Jackson.

C. Pele's hair, Kilauea, 1840. B. Silliman, Jr.

D. Pele's hair, same source and analyst.

E. Pele's hair, light colored. Analyzed by J. Peabody.

F. Recent vitreous basalt, fresh and unaltered. Silvestri.[16]

G. Older basalt, but fresh. Silvestri.

H. Older basalt, much altered. Silvestri.

I. Compact basalt-obsidian. Cohen.[17]

K. Pele's hair. Cohen.

Another form of lava has been found and may be found again, a fragment of which is shown in Fig. 29. In a blow-hole the late Mr. H. Rexford Hitchcock found some specimens which seem to me to have been formed by an electric current acting on a plastic mass containing much iron. The masses are of considerable specific gravity (2.857), and the surface is arranged precisely as iron filings place themselves around the pole of a magnet. Similar specimens were found in Vesuvius, but in Kilauea only this one locality has been discovered, and the specimens referred to are (or were) in the Museum of the Boston Society of Natural History.

---

[16] Comitato Geologico d'Italia, Bolletino, 1888, xix, 128, 168.

[17] N. Jahrbuch für Mineralogie, etc., 1880, ii, 23.

Another form of lava is found in narrow seams, and scattered over the ground in places. I am inclined to attribute it to shrinkage cracking.

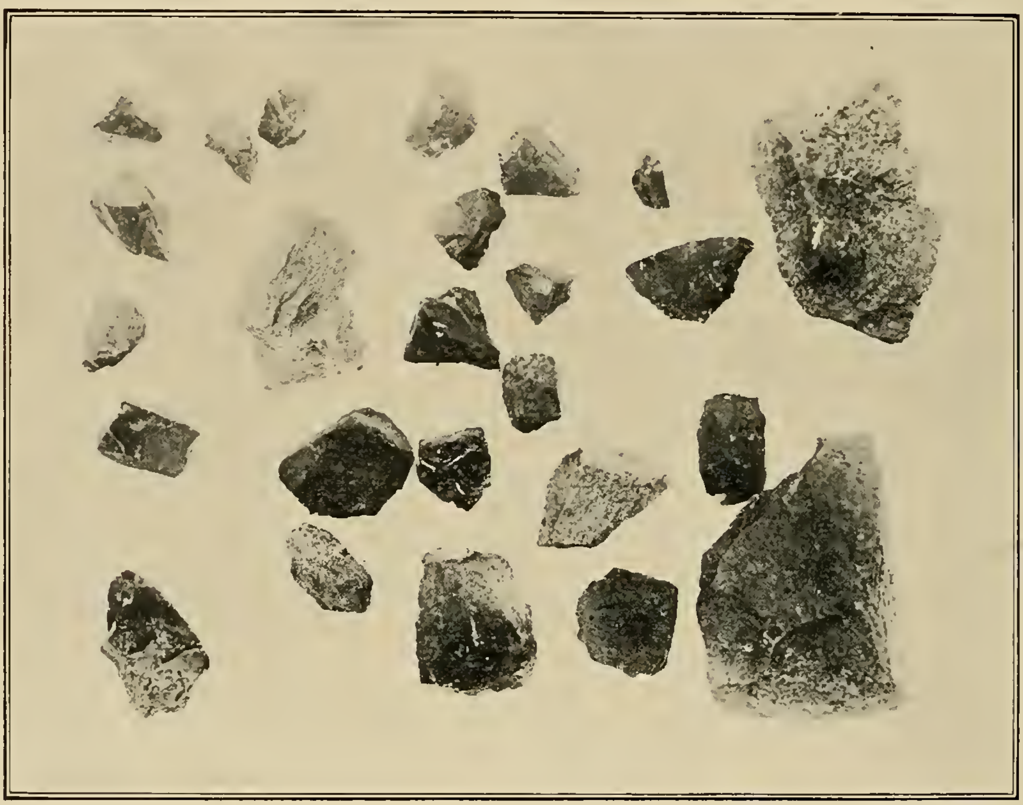


FIG. 30. FRAGMENTARY LAVA.

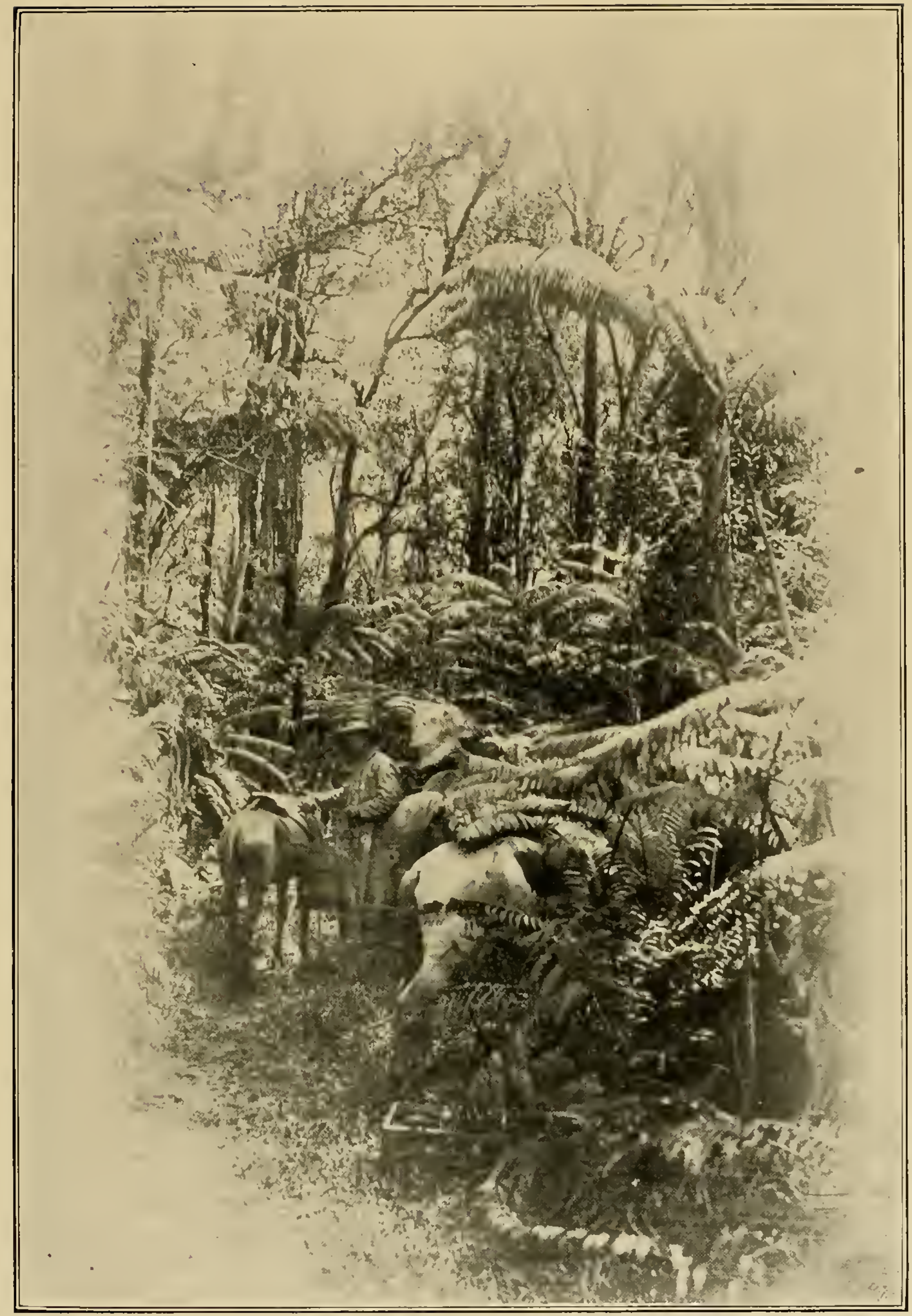


FIG. 31. OHIA FOREST ON THE OLD TRAIL TO KILAUEA.

The Recorded History of the Eruptions.

We may well begin the record of the unusual activities of the Hawaiian volcanoes which are called eruptions, with Kilauea, for of this volcano we have the earliest authentic account. No word of the then shape of the crater; to the Hawaiians, who are our chroniclers, the cup was naught beside its terrible contents,—and these are reported clearly and at considerable length. There is no reason to doubt **1789** the substantial accuracy of the report of the eruption of 1789, although such a paroxysmal eruption has not since been repeated, for the physical proofs are abundant around the crater in the deposits of limu and sand. In 1864 it was thought that these were mainly on the south and west of the crater in desolate regions exposed to the prevailing winds which would carry the vapors and gases constantly, and the ejecta of any explosive eruption, provided the regular winds prevailed, which they probably did not during the explosive eruption of 1789. It is true that vast deposits of black and fine sand still are found to the leeward of the crater, much more than enough to fill the present vast crater, and a still larger portion must have been carried down the mountain side by the rains (often torrential) of more than a century. Around the greater part of the circumference of the crater bushes and trees had covered the ground, but in recent years the building of a carriage road from Hilo has laid bare deposits of this eruption extending far on the northeast side of Kilauea, and the present work on a road around Kilauea iki has given sections of great interest, showing the easily recognized sand and the even more conspicuous limu, fresh and bright in coloring as on the days of its ejection. A pile of fragments of compact rock of light grey color, then the limu often in green fragments larger than a man's fist; then the grey sand in slightly indicated layers, heaped over the pile of rocks as a nucleus extending to the surface where the vegetation has concealed the formation (Fig. 32).

The bones of the perished warriors I have myself seen in the place where they are said to have died, but the relics were limited to a few thigh bones. To fully appreciate the feelings of the Hawaiians at this time we must note the other historical events bearing on the catastrophe we are about to recount. Kamehameha, the young chief at the court of Kalaniopuu, king or moi of Hawaii, noticed by Lieutenant George Vancouver during Cook's visit as a rather savage looking youth, had become moi of Kona, Kohala and Hamakua, and was striving to subdue the rest of the island of Hawaii. In obedience to priestly counsels Kamehameha had built the last of the great stone temples of his ancestral worship, Puokohalà, on the hill overlooking the

Bay of Kawaihae on the west side of the island and in the midst of his kingdom. It was dedicated to his god Kukailimoku (Ku who shakes the islands), and for this pious work the reward promised was the kingship of the entire group. To a religious people such as the old Hawaiians undoubtedly were, the gods were real beings quite able to keep their promises, and yet the feudal duties to their chiefs kept the people in great uncertainty how this result was to be brought about. It seems that the building of the heiau or temple was looked upon by the whole people of Hawaii with interest or terror as they were with Kamehameha or against him in fealty to their own moi. Prominent among the opponents of the future conqueror was Keoua, moi of Kau and Puna, and as an attack on his district of Kau had been made by the men of Kamehameha, Keoua was hastily summoned from Hilo where he was trying to raise help against the man who was still considered an usurper. The trail from Hilo to Kau led by the crater of Kilauea, and on a cliff overlooking the volcano was the ancient temple of Oalalano, dedicated to Pele and her family deities of the volcanic realms, where lived Kamakaakaakua (the eye of god), a noted soothsayer. The record is silent, naturally, as the story was told to missionaries of the new faith, of the offerings no doubt made to the dreaded deities at this place. The trail continued along the northern edge of Kilauea by Uwekahuna, the highest part of the wall, and on southward of the present road to Kapapala. It was the trail by which, in 1864, Mr. Mann and myself approached the volcano in our journey around Hawaii.

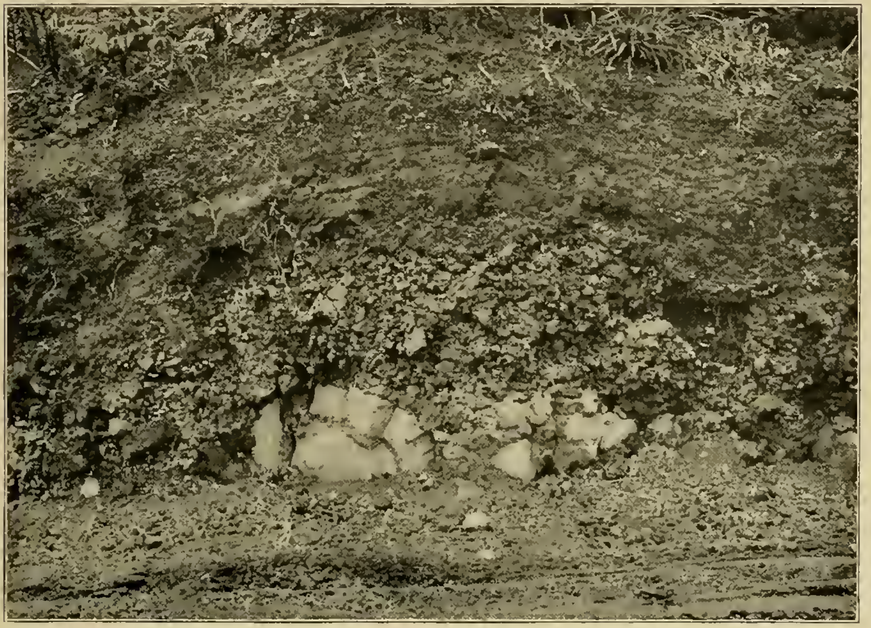


FIG. 32. SECTION ON ROAD NORTH OF KILAUEA IKI.

Keoua and his army encamped probably on the level ground near the temple Oalalauo. During the night the eruption began by throwing out cinders and even heavy stones, the whole accompanied by the glare of molten lava, thunder and lightning. Fearstruck, the party in the morning did not dare to go on, but spent the day in making offerings to Pele, but as on the next two nights there were similar disturbances they at last set out in three divisions. I now quote the account given by the Rev. Sheldon Dibble,[18] taken from those who survived this terrible journey:

> The company in advance had not proceeded far, before the ground began to shake and rock beneath their feet, and it became quite impossible to stand. Soon a dense cloud of darkness was seen to rise out of the crater, and almost at the same instant the thunder began to roar in the heavens and the lightning to flash. It continued to ascend and spread abroad until the whole region was enveloped, and the light of day was entirely excluded. The darkness was the more terrific, being made visible by an awful glare from streams of red and blue light variously combined, that issued from the pit below, and lit up at intervals by the intense flashes of lightning from above. Soon followed an immense volume of sand and cinders which were thrown in high heaven and came down in a destructive shower for many miles around. Some few persons of the forward company were burned to death by the sand and cinders, and others were seriously injured. All experienced a suffocating sensation upon the lungs and hastened on with all possible speed.
>
> The rear body, which was nearest the volcano at the time of the eruption, seemed to suffer the least injury, and after the earthquake and shower of sand had passed over, hastened forward to escape the dangers which threatened them, and rejoicing in mutual congratulations that they had been preserved in the midst of such imminent peril. But what was their surprise and consternation, when on coming up with their comrades of the centre party, they discovered them all to have become corpses. Some were lying down, and others were sitting upright clasping with dying grasp, their wives and children, and joining noses (their form of expressing affection) as in the act of taking a final leave. So much like life they looked, that they at first supposed them merely at rest, and it

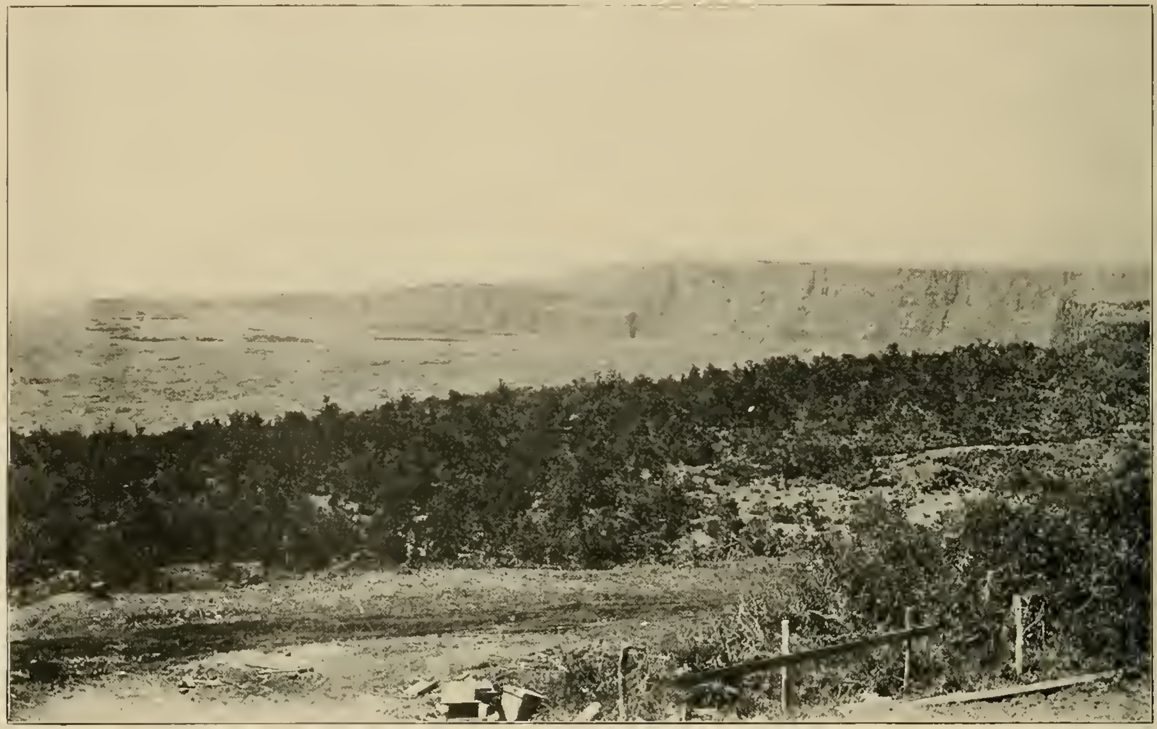


FIG. 33. UWEKAHUNA FROM VOLCANO HOUSE.

---

[18] History of the Sandwich Islands, by Sheldon Dibble. Lahainaluna, 1843, p. 65.

was not until they had come up to them and handled them, that they could detect their mistake. The whole party, including women and children, not one of them survived to relate the catastrophe that had befallen their comrades. The only living being they found was a solitary hog, in company with one of the families that had been so suddenly bereft of life. In those perilous circumstances, the surviving party did not even stay to bewail their fate, but leaving their deceased companions as they found them, hurried on and overtook the company in advance at the place of their encampment.

In a few days from this time the army of Keoua met their enemies and joined in several battles. At length Kameeiamoku went to Keoua in the disguise of a friend, and with much smooth speech and fair promises, prevailed on him to go to Kawaihae and have an interview with Kamehameha. Keoua and his followers, of whom the narrators of this scene were a part, retreated in the direction they had come. On their return they found their deceased friends as they had left them, entire, and exhibiting no other marks of decay, than a sunken hollowness in their eyes; the rest of their bodies were in a state of entire preservation. They were never buried, and their bones lay bleaching in the sun and rain for many years.

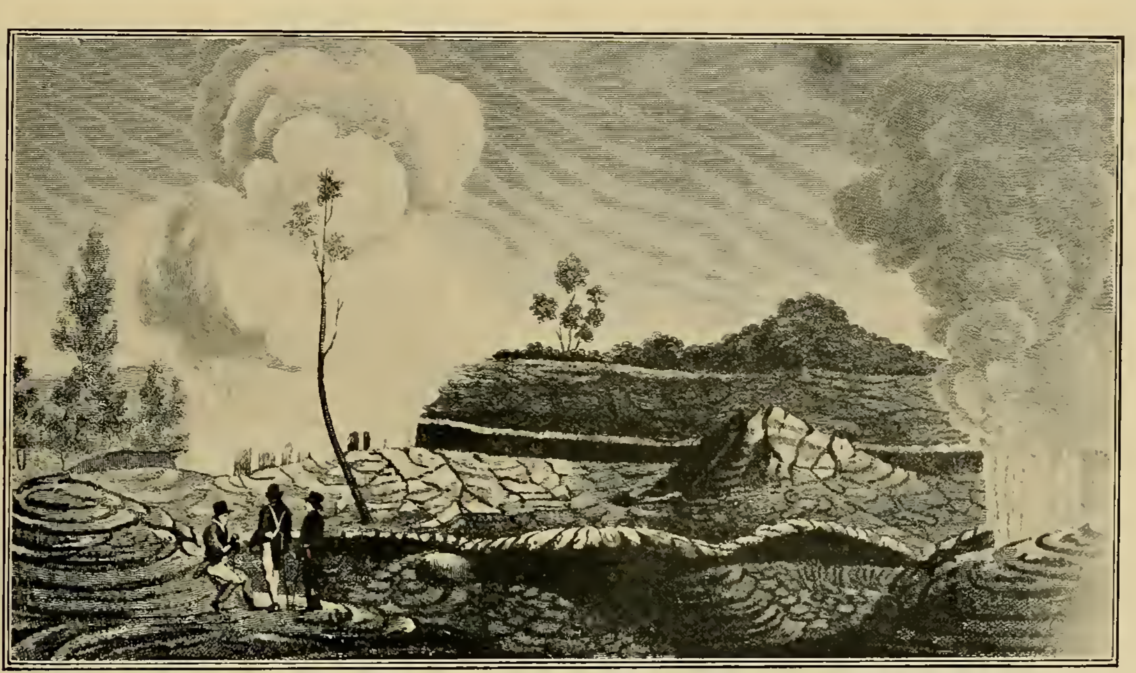


FIG. 34. CRACKS AT PONAHOHOA. FROM PLATE IN ELLIS' TOUR OF HAWAII.

Keoua went on to Kawaihae trusting in the false chiefs, and on landing was treacherously murdered with his companions and their bodies offered as a pleasing sacrifice on the altar of the new temple. It is claimed that this was not done by the orders of Kamehameha. No doubt the popular belief was that Pele was fighting for Kamehameha, and this helped out the promise of the priests.

The description of this eruption at once reminds us of the eruption of Vesuvius in 79 A.D.; the same black, lofty column of smoke spreading out at a great height, lightnings, and the destructive showers of sand such as overwhelmed Pompeii. Could it have marked as in the Italian volcano, a renewal of activity after a long rest, and were the scoriæ the remains of the long-cooled crust at the bottom of the crater? South and west of Kilauea where the sand deposits are quite extensive, the whole ground is cracked with earthquake throes. These rents are sometimes filled with the black sand, and sometimes, especially near Ponahohoa, with lava. It seems probable that from these cracks came the steam or vapor so destructive to the army, as those nearer the crater did not suffer from this cause.

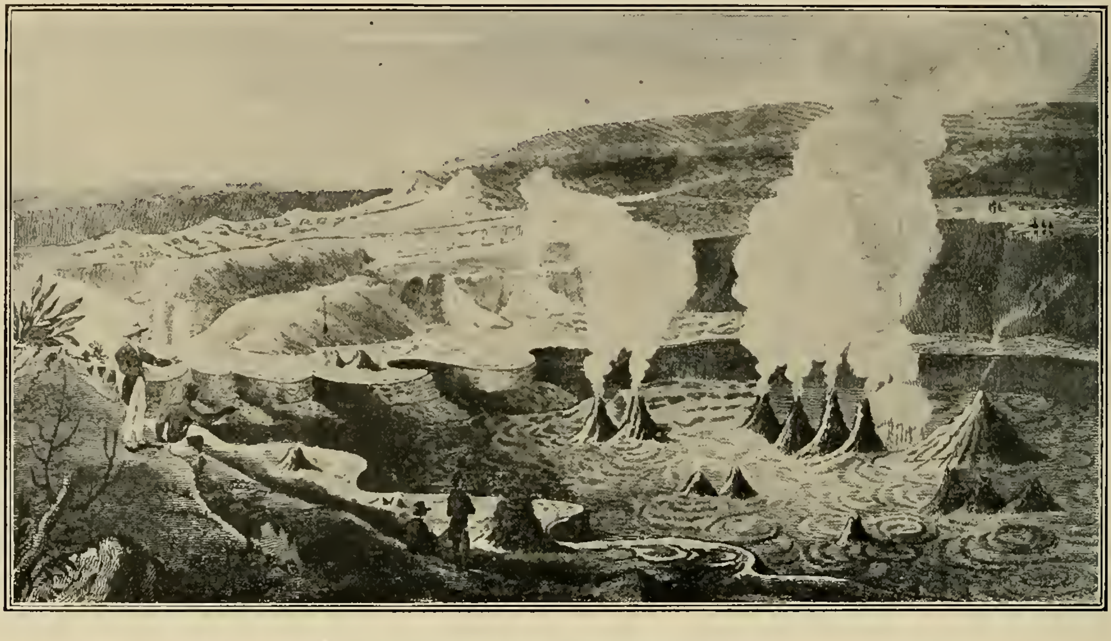


FIG. 35. VIEW OF KILAUEA AS SEEN BY ELLIS.

The appearance of Kilauea as described by Mr. Ellis, who visited it in 1823 and was the first to publish an account of it, was quite unlike its present condition. In the various editions of Ellis' Tour of Hawaii the illustrations made from his original sketch do not agree, and I have selected that given in the London edition, presumably published under the author's supervision; also a later one made for his Polynesian Researches, **1823** published in 1839 (Fig. 36). The crater was evidently in an unfilled state, and was emptying itself, as the action was much diminished when he revisited the scene the next year. It may be allowable to consider 1823 the date of an eruption, although no lava-stream, if we except the traces at Ponahohoa, appeared above ground.[19] The volcano discharged as usual by a lateral rent, the side walls of the dome yielding before the pressure of the enclosed lava, and quietly allowing the passage of the molten current to the sea. It was, I confess, a little puzzling to me, when I gave this opinion forty years ago, how the crater could be leaking out to any extent and yet be so active on the surface as Ellis describes it, but I have since seen more of the working of this wonderful place and am no longer puzzled. I have seen the bottom drop out and leave the Halemaumau quite empty, and the process was a silent one with no activity on the surface. I have again seen the surface in the pit fall so rapidly that there could be no doubt that the supply was tapped, and some interruption intervening; the subsidence not only stopped but the action on the surface became more violent than for a long time. This last seems to have been the case in August, 1823, when he saw what he describes as follows:

---

[19] I have since seen the outflow of this eruption as marked on the map of Hawaii.

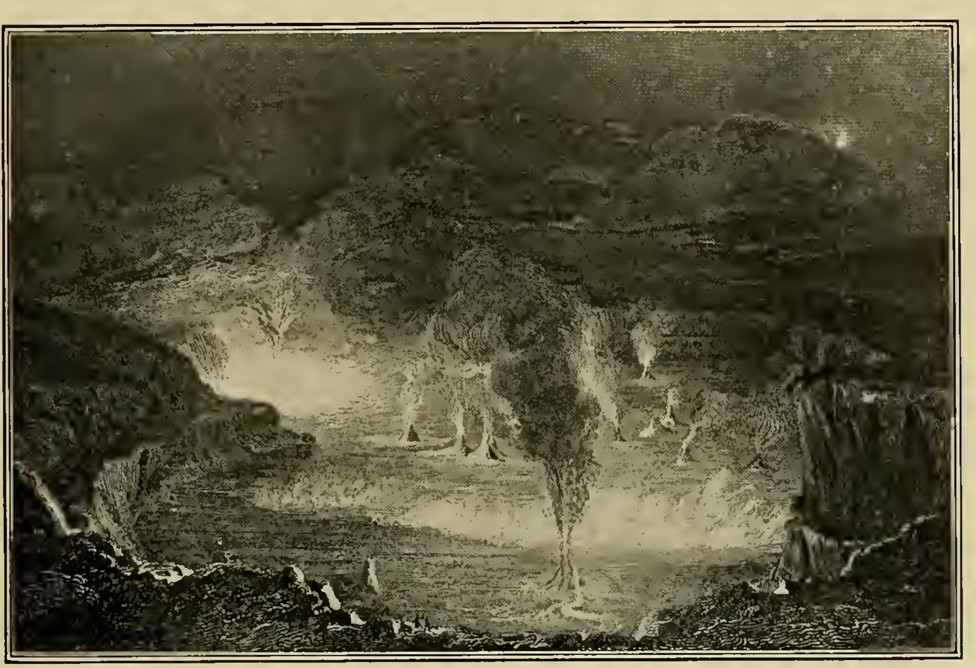


FIG. 36. VIEW OF KILAUEA. ELLIS, IN POLYNESIAN RESEARCHES.

> Immediately before us yawned an immense gulf, in the form of a crescent, upwards of two miles in length, about a mile across, and apparently eight hundred feet deep. The bottom was filled with lava, and the southwest and northern parts of it were one vast flood of liquid fire in a state of terrific ebullition, rolling to and fro its fiery surge and flaming billows. Fifty-one craters of varied form and size rose like so many conical islands from the surface of the burning lake. Twenty-two constantly emitted columns of gray smoke, or pyramids of brilliant flame, and many of them at the same time vomited from their ignited mouths streams of florid lava which rolled in blazing torrents down their black indented sides into the boiling mass below.
>
> The sides of the gulf before us were perpendicular for about four hundred feet, when there was a wide horizontal ledge of solid black lava of irregular breadth, but extending completely round. Beneath this black ledge the sides sloped to the centre, which was, as nearly as we could judge,

three or four hundred feet lower. It was evident that the crater had been recently filled with liquid lava up to this black ledge, and had, by some subterranean canal, emptied itself into the sea, or inundated the low land on the shore. Between nine and ten [in the evening], the dark clouds and heavy fog that since the setting of the sun had hung over the volcano, gradually cleared away. The agitated mass of liquid lava, like a flood of molten metal, raged with tumultuous whirl. The lively flame that danced over its undulating surface tinged with sulphurous blue, or glowing with mineral red, cast a broad glare of dazzling light on the indented sides of the insulated craters whose bellowing mouths, amidst rising flames, shot up at frequent intervals with loudest detonations, spherical masses of fusing lava, or bright ignited stones...... In passing along the eastern side of the crater, we entered several small craters that had been in vigorous action but a short period before, marks of very recent fusion presenting themselves on every side. Their size and height was various, and many which from the top had appeared insignificant as mole hills, we now found to be twelve or twenty feet high. The outsides were composed of bright shining lava, heaped up in piles of most singular form. The lava on the inside was of a light or dark-red color with a glazed surface, and in several places, where the heat had evidently been intense, we saw a deposit of small and beautifully white crystals...... In the neighborhood we saw several large rocks of a dark gray color weighing probably from one to four or five tons, which although they did not bear any marks of fire, must have been ejected from the great crater during some violent eruption, as the surrounding rocks in every direction presented a very different appearance. They were hard, and exhibited, when fractured, a glimmering and uneven surface. As we traveled on from this spot, we unexpectedly came upon another deep crater, nearly half as large as the former. The native name of it is Kilauea iki or Little Kilauea [see the surveys of Kilauea in 1865]. It is separated from the large crater by an isthmus nearly one hundred yards wide. Its sides were covered with trees or shrubs, but the bottom was filled with lava, either fluid or scarcely cold, and probably supplied by the great crater, as the trees on its sides showed that it had remained many years in a state of quiescence.[20]

The next year Kilauea is described as follows:[21]

From the time we arrived within two miles of the crater, we had the smoke arising from it directly in our faces, attended with a sulphureous stench. The wind was very strong and brought along with it fine particles of sand so that I found it necessary to draw my hat as close as possible, over my eyes in order to preserve them, carrying my head at the same time pretty low. The travelling was also difficult from the sand which covered the smooth stones on which we had before walked. Into this sand our feet sunk six or eight inches at every step. We however sometimes found the sand sufficiently hard and compact to bear us up...... We reached several large crevices from which smoke was issuing at a distance of five miles from the crater. Continuing to advance toward the crater our attention was arrested by a hissing noise like that of the blowing of a furnace, except that it was irregular, the noise being sometimes very low, and then again exceedingly loud. The smoke in which we were now enveloped became so dense that we could see only a small distance before us...... We had made the volcano at the southwest end, and we now proceeded round the eastern side hoping to be soon freed from the steam or smoke, which being condensed by the wind, was falling upon us like rain...... At the distance of two hundred and fifty or three hundred feet below us was a level platform which appeared to have been formed by the falling in of the wall of the crater. This platform, I believe, extends nearly around the whole of the crater which is supposed to be nearly six miles in circumference. I had little difficulty in descending to this platform. From the side where I descended it extends nearly fifteen rods towards the centre of the crater, where there is another descent of two hundred and fifty or three hundred feet.

1824

---

[20] Ellis, Tour of Hawaii, p. 224.

[21] The writer has been permitted to extract this account from the unpublished journal of Edward Loomis, who was connected with the American Mission, and visited the volcano on June 16, 1824. He approached the crater from Kau on the southwest.

> Down this I proceeded, though not without danger, it being in most places perpendicular, and nearly so where I descended. Many of the stones also on which it was necessary to step were loose.... I had now reached the ancient bed of the volcano, having, as I supposed, descended six hundred feet. The surface of the lava was smooth though not level, sometimes rising in heaps like cocks of hay, and broken by innumerable fissures crossing each other in various directions.
>
> This lava was of a deep black color, exceedingly porous, and as light as a pumice stone. The steam was constantly issuing from the crevices, and was so hot that I could not hold my hand in it for a moment. On this bed of lava I walked eight or ten rods towards the centre of the crater, when I came to another descent of two or three hundred feet, the volcano having sunk thus far below its ancient bed. The lower bed appeared much like the one on which I stood, but from various parts of it not only smoke, but flames of fire were issuing. The appearance of these small craters where the fire was bursting out, attended with a horrid noise, was indeed awfully grand, but I was disappointed in not finding the lower bed a mass of liquid fire. About a year since when several of our brethren were making the tour of this island, this lower bed of lava was in a liquid state. The surface has now become hard, and I have no doubt would have supported my weight could I have descended to it. This I wished to do, but I looked in vain for a place where I might descend, the sides being in most places shelving over or perpendicular......I proceeded along to the base of the sulphur mountain to collect specimens to carry home. It was in those places from which the smoke was issuing that I found the sulphur most pure, and formed into beautiful crystals.

Mr. Ellis also revisited the crater this year and noticed the greatly decreased activity. The next year, July 28, 1825, Kilauea was visited by the Rev. C. S. Stewart, who described its appearance as follows:

> About midway from the top a ledge of lava, in some places only a few feet, in others many rods wide, extends entirely round, at least so far as an examination has been made, forming a kind of gallery to which you can descend in two or three places, and walk as far as the smoke settling at the south end will permit......The gulf below contains probably not less than sixty,—fifty-six have been counted,—smaller conical craters, many of which are in constant action. The tops **1825** and sides of two or three of these are covered with sulphur of mingled shades of yellow and green. With this exception, the ledge and everything below it are of a dismal black. The upper cliffs on the northern and western sides are perfectly perpendicular, and of a red color, everywhere exhibiting the seared marks of former powerful ignition. Those on the eastern side are less precipitous, and consist of entire banks of sulphur of a delicate and beautiful yellow. The south end is wholly obscured by smoke which fills that part of the crater and spreads widely over the surrounding horizon......Two or three of the smaller craters nearest to us were in full action, every moment casting out stones, ashes and lava, with heavy detonations, while the irritated flames accompanying them glared widely over the surrounding obscurity......The great seat of action, however, seemed to be at the southwestern end......Rivers of fire were seen rolling in splendid corruscations among the laboring craters, and on one side a whole lake whose surface constantly flashed and sparkled with the agitation of contending currents......At an inconsiderable distance from us was one of the largest of the conical craters whose laborious action had so impressed us during the night. On reaching its base we judged it to be one hundred and fifty feet high—a huge irregularly shapen, inverted funnel of lava, covered with clefts, orifices and tunnels from which bodies of steam escaped with deafening explosion, while pale flames, ashes, stones and lava were propelled with equal force and noise from its ragged and yawning mouth....Leaving the sulphur banks on the eastern side behind us we directed our course along the northern part to the western cliffs. As we advanced, these became more and more perpendicular, till they presented nothing but the bare and upright face of an immense wall, from eight to ten hundred feet high, on whose surface huge stones and rocks

hung—apparently so loosely as to threaten falling, at the agitation of a breath. In many places a white curling vapor issued from the sides and summit of the precipice, and in two or three places streams of clay-colored lava, like small waterfalls, extending almost from the top to the bottom, had cooled evidently at a very recent period.

Lieutenant Malden, of H. B. M. S. Blonde, who accompanied Mr. Stewart, made a plan of the crater which is here reproduced, with the sketch of the crater by Robert Dampier, the artist of the Blonde. Malden calculated the height of the upper cliff from the black ledge at nine hundred feet, making the whole depth of the crater 1500 feet; and the circumference of the crater at its bottom, from five to seven miles, and at its top from eight to ten miles. On the evening of the twenty-ninth, after terrific noises and tremblings of the ground, "a dense column of heavy black smoke was seen rising from the crater directly in front of us [Lord Byron's camp was on the isthmus between the main crater and Kilauea iki], the subterranean struggle ceased, and immediately after flames burst from a large cone, near which we had been in the morning, and which then appeared to have been long inactive. Red-hot stones, cinders and ashes, were also propelled to a great height with immense violence; and shortly after the molten lava came boiling up, and flowed down the sides of the cone, and over the surrounding scoriæ, in two beautifully curved streams."[22] At the same time a whole lake opened over an extent two miles in circumference.

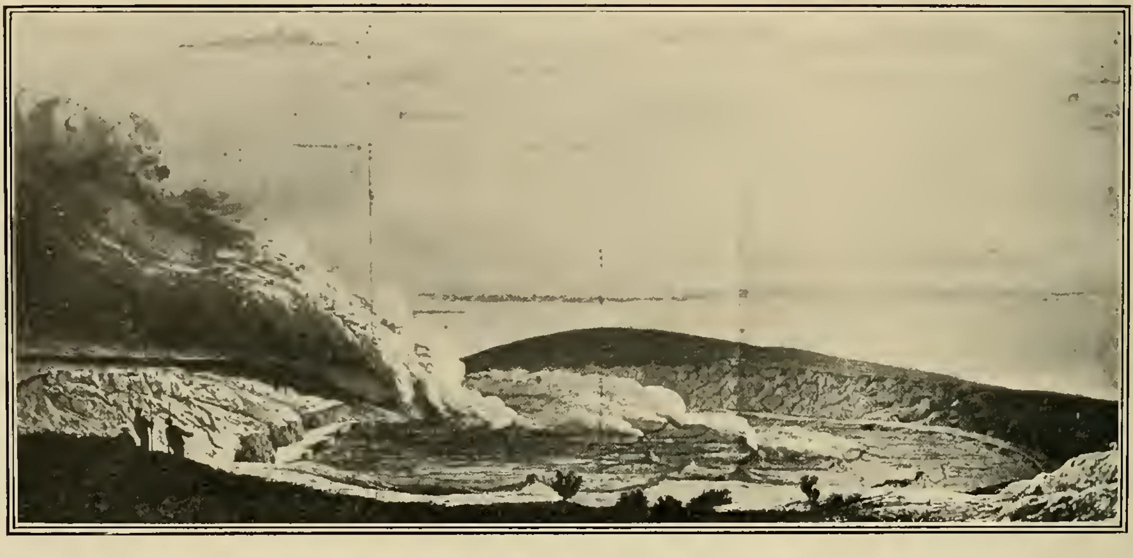


FIG. 37. DAMPIER'S VIEW OF KILAUEA IN 1825.

In December of the same year Rev. Artemus Bishop found the crater much fuller than when he had visited it with Rev. W. Ellis in 1823. There were many cones from fifty to one hundred feet high on a surface about four hundred feet higher

---

[22] Byron, Narrative of the Voyage of H. M. S. Blonde to the Sandwich Islands in 1824-1825, p. 190. London, 1827.

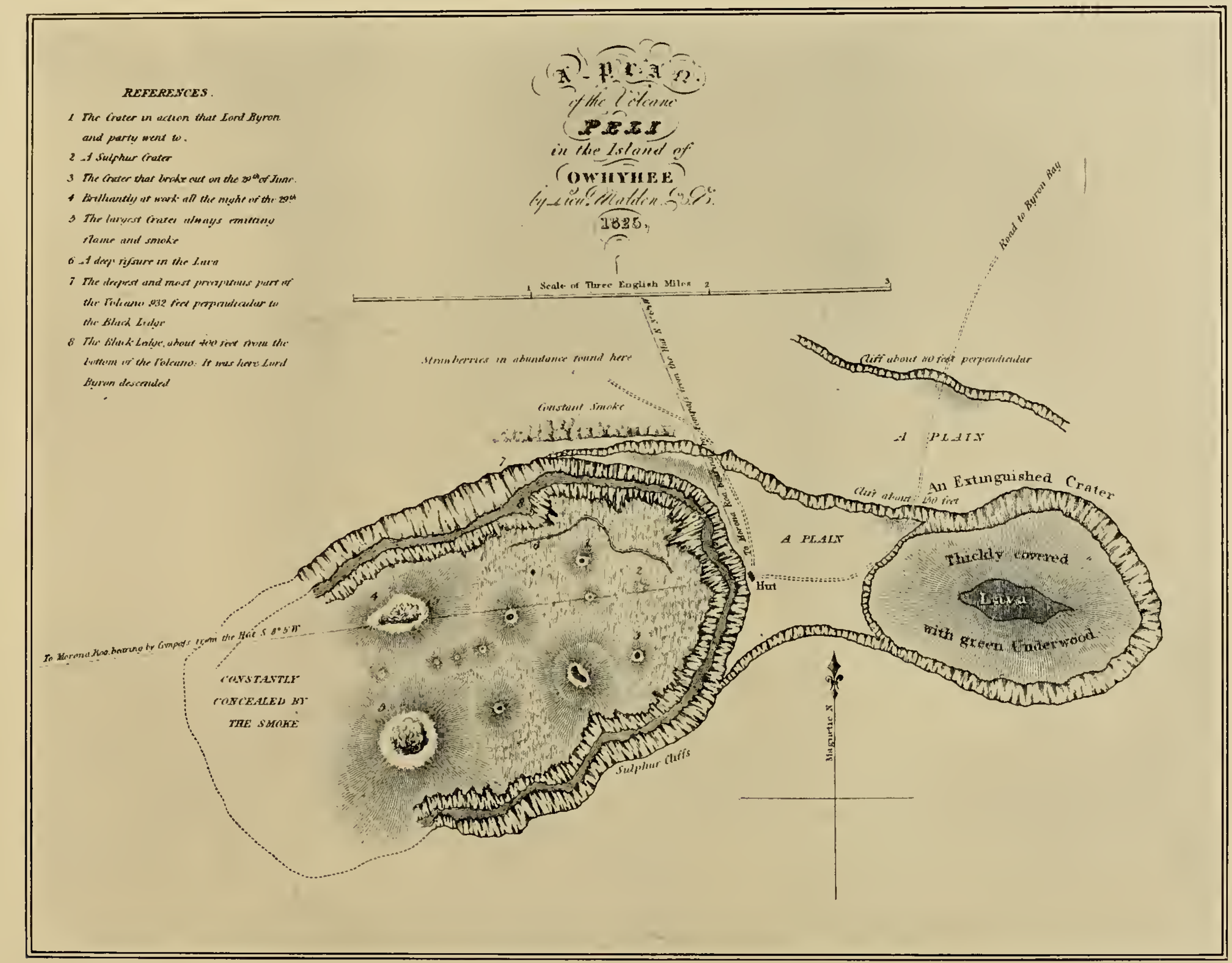

A PLAN
of the Volcano
PELI
in the Island of
OWHYHEE
by Lieut. Malden, &c.
1825.
REFERENCES.
1 The Crater in action that Lord Byron and party went to.
2 A Sulphur Crater
3 The Crater that broke out on the 29th of June.
4 Brilliantly at work all the night of the 29th
5 The largest Crater always emitting flame and smoke
6 A deep fissure in the Lava
7 The deepest and most precipitous part of the Volcano 932 feet perpendicular to the Black Ledge
8 The Black Ledge, about 400 feet from the bottom of the Volcano: It was here Lord Byron descended
1 Scale of Three English Miles 2 3
Strawberries in abundance found here
Constant Smoke
Compass from the Hut N 5° E
To Morona Roa bearing by Compass from the Hut S 8° 5 W
CONSTANTLY CONCEALED BY THE SMOKE
Sulphur Cliffs
To Morona Roa
Hut
A PLAIN
A PLAIN
Cliff about 80 feet perpendicular
Cliff about 150 feet
Road to Byron Bay
An Extinguished Crater
Thickly covered with green Underwood
Lava
Magnetic N

FIG. 38. PLAN OF THE CRATER BY LIEUTENANT MALDEN.

than the bottom of the crater two years before. There were lakes boiling actively, and "every now and then sending forth a gust of vapor and smoke with great noise. The natives remarked that after rising a little higher the lava will discharge itself, as formerly, toward the sea through some aperture underground."[23] In the
1829 early part of October, 1829, the Rev. C. S. Stewart again visited the crater.
He found the lower pit filled up more than two hundred feet; many of the cones had disappeared, and there was much more fire at the northern end. He thus describes two cones which he examined:

> They were in the neighborhood of each other—each about twenty feet in height, not more than sixty in circumference at the base, and tapering almost to a point at the top—being in fact two immense hollow columns formed by successive slight overflowings of lava, cooling as it rolled down, into irregular flutings, ornamented with rude drops and pendants, and long tapering stalactites. Though the ragings beneath must have been intense, from the tremendous roar within, the irresistible force and deafening hiss with which the steam rushed from every opening, and from the flames which flashed up, followed by lava white with an intensity of heat, still the incrustation of scoriæ immediately around seemed firm, and was less hot than in many other places; admitting not only of our coming close to the sides of the cone, but also of clambering some feet up them, till we could run our canes into the orifices at the top, and withdraw with their burning ends, red-hot lava, on which we readily made impressions. Pele did not seem well pleased with this familiarity, however; even the slightest touch with our sticks against the molten lava, produced an increased rush and roar from below, with an angry spitting of the fiery matter high in the air around us."[24]

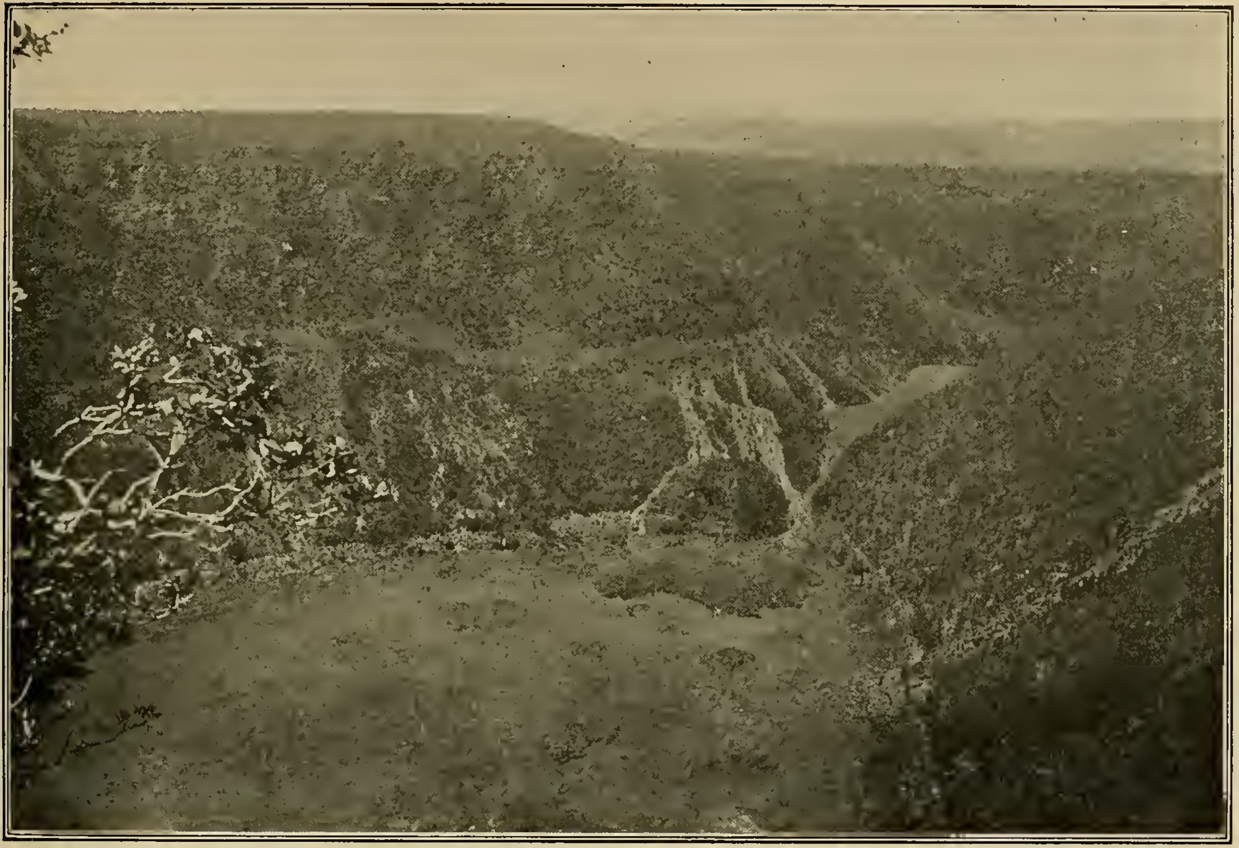
Four years after, an eruption took place simultaneously with one from the summit of Mauna Loa. Unfortunately we have no account from any eye-witness. In September, 1832, the Rev. J. Goodrich visited Kilauea, and describes the appearance of the emptied crater: "The lavas had previously risen fifty feet above the black ledge, but were now more than four hundred feet below this level and the
1832 action seemed confined to Halemauman at the south end. In January an
earthquake had rent in twain the wall between Kilauea and Kilauea iki, the large crater on the east, producing seams from a few inches to several yards in width, from which the region between the two craters was deluged with lava."[25] The outbreak on the wall was very remarkable, rising as it did in a strip of land four hundred yards wide bounded by precipices on either side some two hundred feet high and apparently as loose as a dry-laid wall. Before this time Kilauea iki had long been free from lava visitations, and its sides were wooded to the bottom. The stream issued from several rents south of the centre of the isthmus and above the lowest part, flowed toward the north a few yards to the lowest part, and then divided and ran east and west into the two craters in a shallow stream; indeed the quantity of lava was so small, that its eruption is hardly more important than the action of slender cones as described by

---

[23] Missionary Herald, vol. xxiii, p. 53.
[24] A Visit to the South Seas, vol. ii, p. 93.
[25] American Journal of Science (N. S.), vol. xxv, p. 199.

Mr. Stewart. Where the subterranean discharge which emptied the crater and must have been of great volume, is not known. It may have been, probably was, one of the submarine eruptions which have been marked only by a more or less tidal wave or merely by the number of dead fish along the shore.

1834 David Douglas, the Scotch botanist who lost his life in a cattle trap on Hawaii, and who made the first recorded ascent of Mauna Loa, was at Kilauea in January, 1834, and measured the depth of the pit at one thousand feet. A lake of boiling lava at the north end was three hundred and nineteen yards in diameter. Halemaumau was much as described by Ellis.[26]



Perkins. FIG. 39. VIEW OF THE LAVA STREAMS OF 1832 AND LATER.

1838 On the eighth of May, 1838, Captains Chase and Parker visited Kilauea, and their description has been published with a sketch of the crater. The lavas had again nearly reached the black ledge, and all over a surface of four square miles were cones and lakes of fire; twenty-six of the former were counted, eight of which were ejecting cinders and red-hot lava. Six small lakes were boiling violently, becoming crusted over, cracking, and again boiling. In the Halemaumau was an island which the lava was not seen to overflow; the first notice of a phenomenon observed several times since. The remarkable oscillations in the heat, remarked by all visitors, seem to have taken place on this occasion with more than the usual rapidity. As they were looking at one of the lakes which was boiling violently, they say: "After a few minutes the violent struggle ceased, and the whole surface of the lake was changed to a black mass of scoriæ; but the pause was only to renew its exertions; for, while they were gazing at the change, suddenly the entire crust which had been formed, commenced cracking, and the burning lava soon rolled across the lake, heaving the coating on its surface like cakes of ice upon the ocean surge." As they left the crater, nearly a quarter of the floor gave way, forming a vast pool of liquid lava.[27]

---

[26] Journal of the Royal Geographical Society, vol. iv, 333, 334. Douglas was at Kilauea January 23-25, and his ascent of Mauna Loa was on the 29th. He was killed in July of the same year.

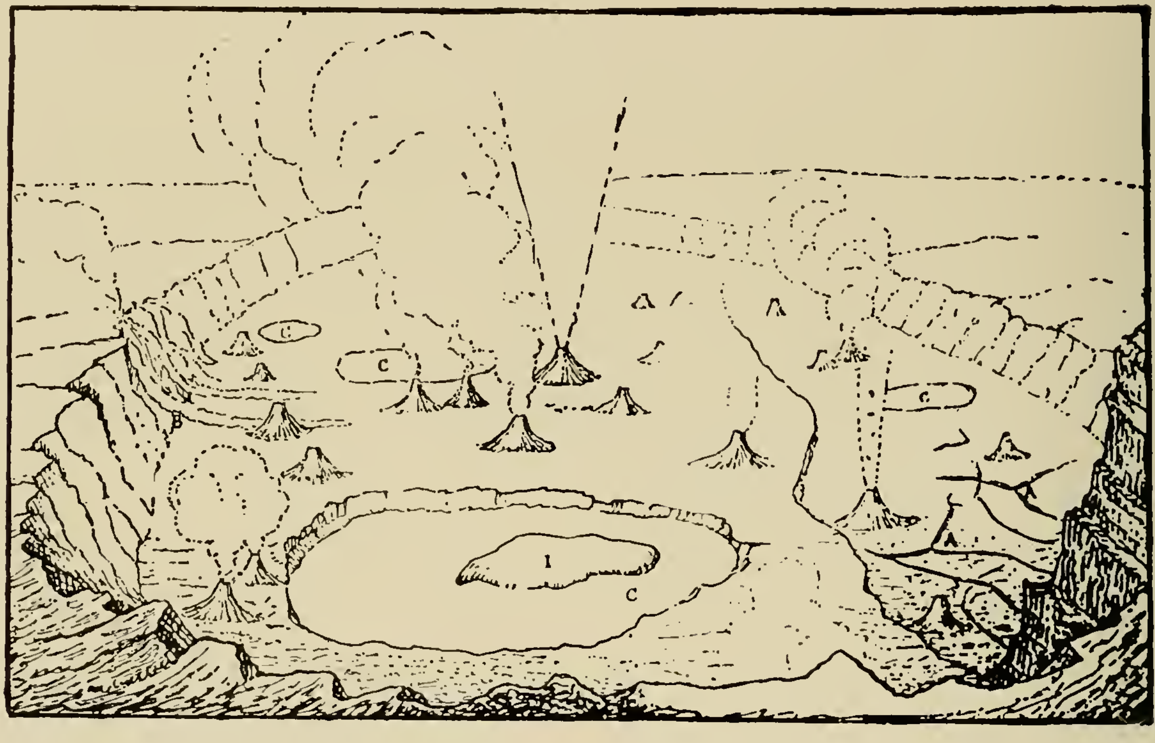


FIG. 40. KILAUEA ACCORDING TO CAPTAINS PARKER AND CHASE. DANA.

Count Strzelecki was at Kilauea in the late summer of the same year and published what seem to be his undigested observations in the Hawaiian Spectator (vol. i, p. 435)[28], but revised them in his work on New Zealand and Van Diemen's Land in 1845. He made barometric measurements at various points, making what seems to be Waldron's Ledge six hundred feet above the boiling surface of lava, and its height above the sea 4100 feet. He first notices the outer walls of the *ancient* crater, calls the terraces around the present crater vast platforms, and makes the highest point of these ancient walls (now much interrupted) 5054 feet. In all the modern surveys of the crater these "ancient walls" have been neglected, although the early visitors often refer to them, as Ellis saw on one of them on the northeast of Kilauea the ruins of the heiau dedicated to Pele. The Count described six lakes of boiling lava, four of which were only three or four feet above the general floor, the fifth forty feet, and the last one hundred and fifty; this he calls *Hau mau mau*, which covered nearly a million square feet, while the others he rates at twelve thousand square feet each. His statement that "the lava sank and rose in all the lakes simultaneously" is, considering the difference in level, very improbable, and in cases where there have been several lakes on nearly the same level no such phenomenon has been reported.

---

[27] Silliman's Journal (N. S.), vol. xl, p. 117 (1841). The plate accompanying their description was redrawn from their sketches by a New Haven artist, and it is given in outline in Dana, Characteristics of Volcanoes, p. 60. The floating island "heaved up and down in the liquid mass," and "rocked like a ship on a stormy sea."

[28] Reprinted in Thrum's Annual.

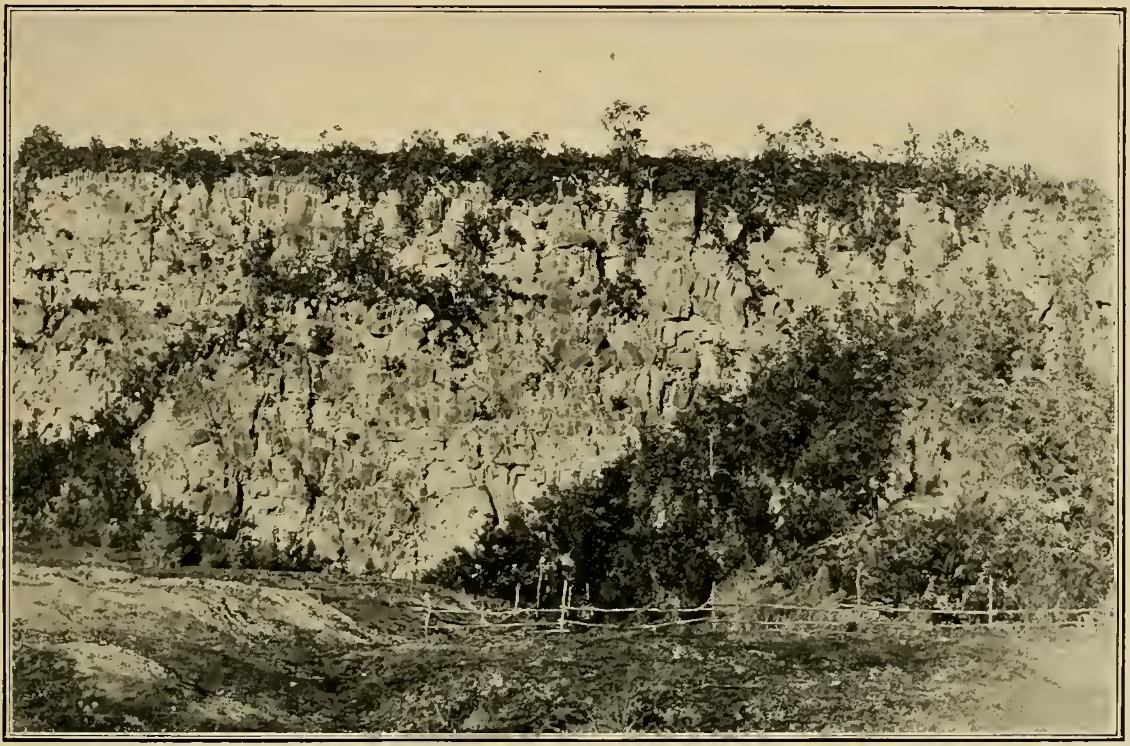


FIG. 41. WALL ON THE NORTH OF KILAUEA IN 1889.

1839

Captain John Shepherd was at the crater September 16, 1839. On his way to the great lake he passed several small lakes and cones, the latter twenty to thirty feet high, from whence issued vapors and lava with loud detonations. He speaks of a lake toward the *east* side of the crater a mile long, and half as wide, within a wall a hundred feet above the general floor. This was "in violent ebullition, with an apparent flow from south to north, caused by the escape of elastic fluids, throwing up the spray in many parts thirty to forty feet." He also mentions that this lake (Halemaumau) overflowed at times.[29]

It took Kilauea nine years to fill up after the eruption of 1823; and now for eight years the process had been continued until the lava had reached a level nearly a hundred feet above the level in 1832. The force tending to rupture the mountain may be readily calculated, assuming the pressure of every twelve feet of lava to be fifteen pounds to the square inch; if the crater is emptied to a depth of four hundred feet, and in recent years the depth has been seven hundred feet, we have a pressure of five hundred pounds to the square inch. It must be remembered that the mountain wall is by no means solid and compact, and although successive discharges may strengthen some volcanic mountains, here the effect seems to be quite the contrary, owing to the extreme fluidity of the lava which runs off, leaving tunnels and caverns instead of solid interlacing dykes; consequently the discharges usually follow the same general direction.

There now comes into this history a man whose name has for many years been connected with Kilauea as its faithful observer and reporter; the Rev. Titus Coan, or Father Coan as those of us who knew and loved him preferred to call him. This excellent missionary was stationed at Hilo and the volcano was included in his parish, and he cared for it as he did for all his parishioners. His letters **1840** to the Missionary Herald, Silliman's Journal, Professor Dana, and myself, contain much information of the crater he loved to visit, and will be freely used here. Father Coan was in Oahu when the great eruption of 1840 took place, but on his return to Hawaii he at once began his investigations. In a letter dated September 25, 1840, he gives us the result:

> For several years past the great crater of Kilauea has been rapidly filling up by the rising of the superincumbent crust, and by the frequent gushing forth of the molten sea below. In this manner the great basin below the black ledge, which has been computed from three to five hundred feet deep, was long since filled up by the ejection and cooling of successive masses of the fiery fluid. These silent eruptions continued to occur at intervals, until the black ledge was repeatedly overflowed, each cooling and forming a new layer from two feet thick and upwards, until the whole area of the crater was filled up, at least fifty feet above the original black ledge, and thus reducing the whole depth of the crater to less than nine hundred feet. This process of filling up continued till the latter part of May, 1840, when, as many natives testify, the whole area of the crater became one entire sea of ignifluous matter, raging like old ocean when lashed into a fury by a tempest. For several days the fires raged with fearful intensity, exhibiting a scene awfully terrific. The infuriated waves sent up infernal sounds, and dashed with such maddening energy against the sides of the awful cauldron, as to shake the solid earth above, and to detach huge masses of overhanging rocks, which, leaving their ancient beds, plunged into the fiery gulf below. So terrific was the scene that no

---

[29] London Atheneum, Nov. 14, 1840, p. 909.

one dared to approach near it, and travellers on the main road, which lay along the verge of the crater, feeling the ground tremble beneath their feet, fled and passed by at a distance. I should be inclined to discredit these statements of the natives, had I not since been to Kilauea and examined it minutely with these reports in view. Every appearance, however, of the crater confirms these reports. Every thing within the cauldron is new. Not a particle of lava remains as it was when I last visited it. All has been melted down and recast...... I will now give a short history of the eruption itself.

On the 30th of May, the people of Puna observed the appearance of smoke and fire in the interior, a mountainous and desolate region of that district. Thinking that the fire might be the burning of some jungle, they took little notice of it until the next day, Sabbath, when the meetings in the different villages were thrown into confusion by sudden and grand exhibitions of fire, on a scale so large and fearful as to leave them no room to doubt the cause of the phenomenon. The fire augmented during the day and night; but it did not seem to flow off rapidly in any direction. All were in consternation, as it was expected that the molten flood would pour itself down from its height of four thousand feet to the coast, and no one knew to what point it would flow, or what devastation would attend its fiery course. On Monday, June 1st, the stream began to flow off in a northeasterly direction, and on the following Wednesday, June 3rd, at evening, the burning river reached the sea, having averaged half a mile an hour in its progress. The rapidity of the flow was very unequal, being modified by the inequalities of the surface, over which the stream passed. Sometimes it is supposed to have moved five miles an hour, and at other times, owing to obstructions, making no apparent progress, except in filling up deep valleys, and in swelling over or breaking away hills and precipices.

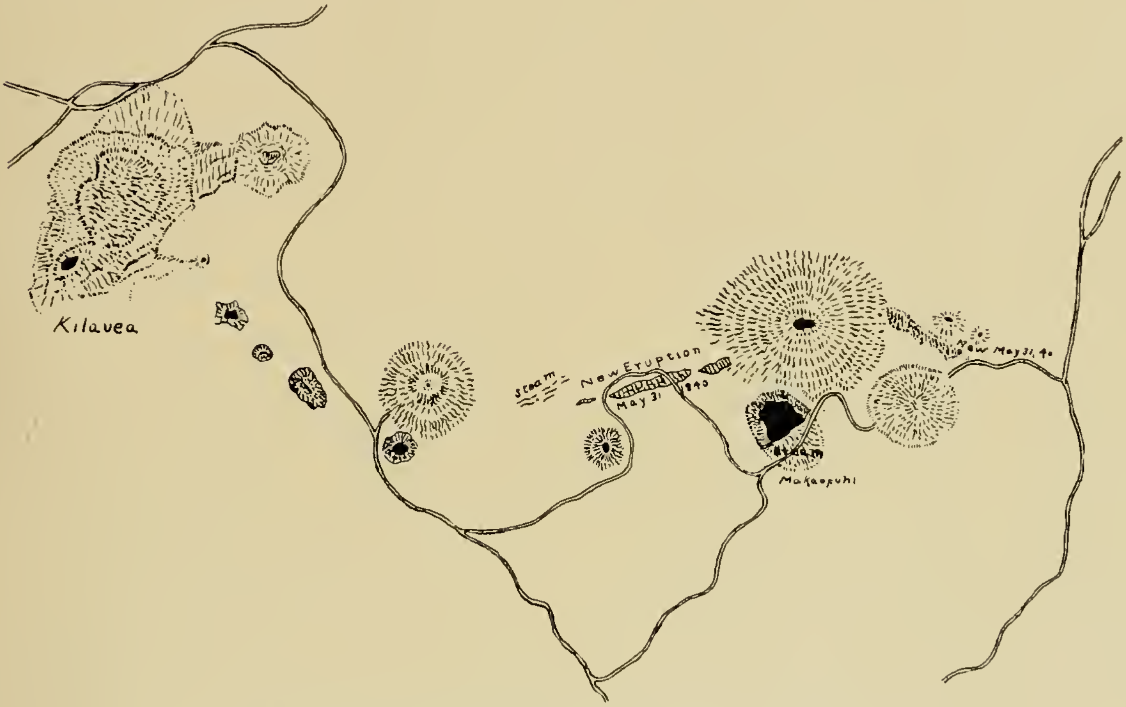
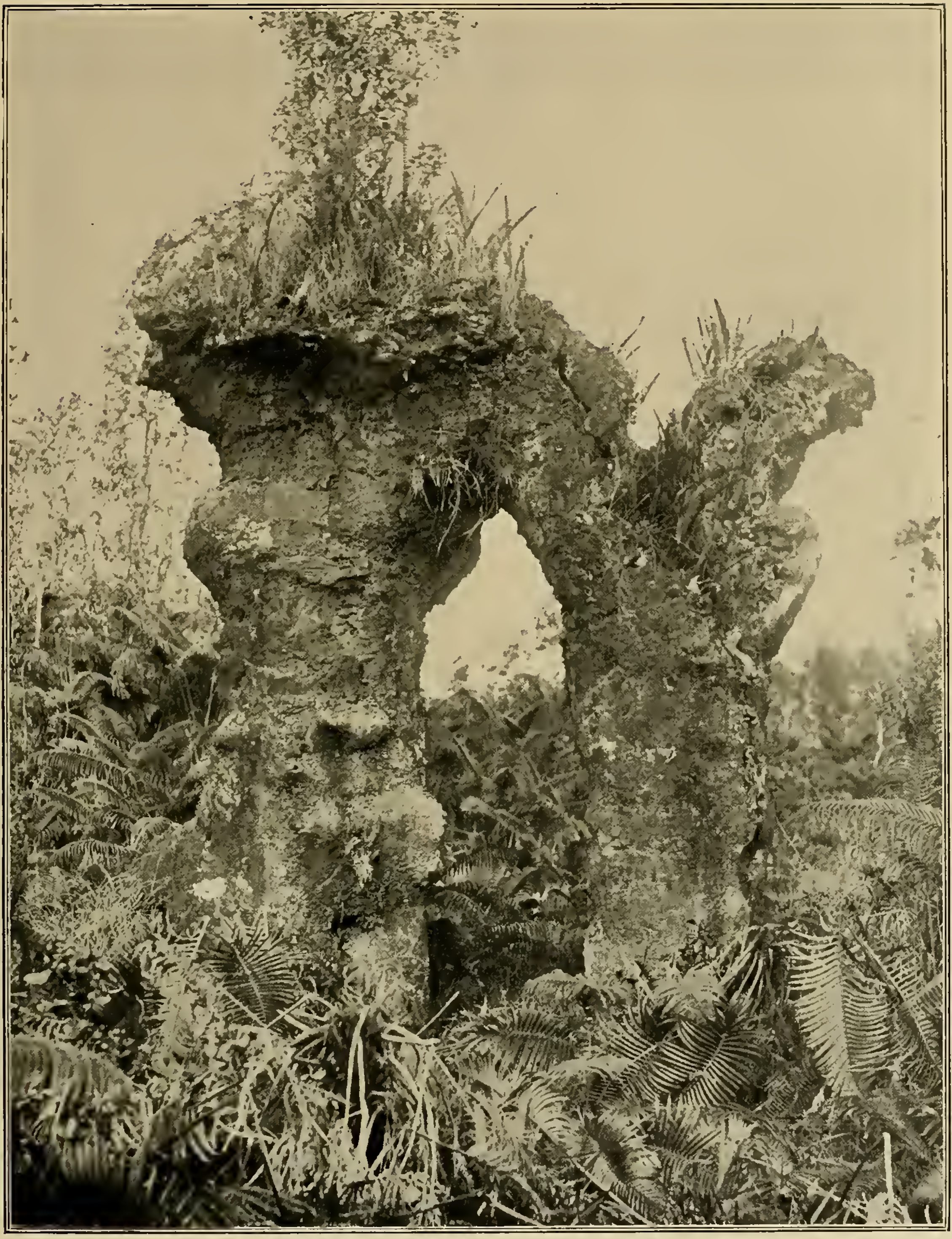


FIG. 42. MAP OF THE REGION OF THE ERUPTION. AFTER WILKES.

But I will return to the source of the eruption. This is in a forest, and in the bottom of an ancient wooded crater, about four hundred feet deep, and probably eight miles east of Kilauea. The region being uninhabited and covered with a thicket, it was some time before the place was discovered; and up to this time, though several foreigners have attempted it, no one, except myself, has reached the spot. From Kilauea to this place the lava flows in a subterranean gallery probably at the depth of a thousand feet, but its course can be distinctly traced all the way by the rending of the crust of the earth into innumerable fissures, and by the emission of smoke, steam and gases. The eruption in this old crater is small, and from this place the stream disappears again for the distance of a mile or two when the lava again gushes up and spreads over an area of about fifty acres. Again it passes underground for two or three miles, when it reappears in another old wooded crater, consuming the forest and partly filling up the basin. Once more it disappears, and flowing in a subterranean channel, cracks and breaks the earth, opening fissures from six inches to ten or twelve feet in width, and sometimes splitting the trunk of a tree so exactly that its legs stand astride at the fissure. At some places it is impossible to trace the subterranean stream on account of the impenetrable thicket under which it passes. After flowing underground several miles, perhaps six or eight, it again broke out like an overwhelming flood, and sweeping forest, hamlet, plantation, and everything before it, rolled down with resistless energy to the sea, where leaping a precipice of forty or fifty feet, it poured itself in one vast cataract of fire into the deep below, with loud detonations, fearful hissings, and a thousand unearthly and indescribable sounds...... The atmosphere in all directions was filled with ashes, spray, gases, etc.; while the burning lava, as it fell into the water was shivered into millions of minute particles, and, being thrown back into the air fell in showers of sand on all the surrounding country. The coast was extended into the sea for a quarter of a mile, and a pretty sand beach, and a new cape were formed. Three hills of scoriæ and sand were also formed in the sea, the lowest about two hundred, and the highest about three hundred feet.

For three weeks this terrific river disgorged itself into the sea with little abatement. Multitudes of fishes were killed, and the waters of the ocean were heated for twenty miles along the coast. The breadth of the stream where it fell into the sea, is about half a mile, but inland it varies from one to four or five miles in width, conforming itself, like a river, to the face of the country over which it flowed. The depth of the stream will probably vary from ten to two hundred feet, according to the inequalities of the surface over which it passed. During the flow. night was converted into day on all eastern Hawaii; the light was visible for more than one hundred miles at sea; and at the distance of forty miles fine print could be read at midnight.

The whole course of the stream from Kilauea to the sea is about forty miles. The ground over which it flowed descends at the rate of one hundred feet to the mile. The crust is now cooled, and may be traversed with care, though scalding steam, pungent gases, and smoke are still emitted in many places. In pursuing my way for nearly two days over this mighty smouldering mass, I was more and more impressed at every step with the wonderful scene. Hills had been melted down like wax; ravines and deep valleys had been filled; and majestic forests had disappeared like a feather in the flames. On the outer edge of the lava, where the stream was more shallow and the heat less vehement, and where of course the liquid mass cooled soonest, the trees were mowed down like grass before the scythe, and left charred, crisp, smouldering, and only half consumed. As the lava flowed around the trunks of large trees on the outskirts of the stream, the melted mass stiffened and consolidated before the trunk was consumed, and when this was effected, the top of the tree fell, and lay unconsumed on the crust, while the hole which marked the place of the trunk remains almost as smooth and perfect as the calibre of a cannon. These holes are innumerable and I found them to measure from ten to forty feet deep, but, as I remarked before, they are in the more shallow part of the lava, the trees being entirely consumed where it was deeper. During the flow of this eruption the great crater of Kilauea sunk about three hundred feet, and her fires became nearly extinct, one lake only out of many being left in the mighty cauldron. This open lake is at present intensely active, and the fires are increasing, as is evident from the glare visible from our station, and from the testimony of visitors. During the early part of the eruption slight and repeated shocks of earthquake were felt, for several successive days, near the scene of action. These shocks were not noticed



Henshaw.

FIG. 43. LAVA AROUND TREES IN PUNA.

at Hilo. Through the directing hand of a kind Providence no lives were lost, and but little property was consumed during this amazing flood of fiery ruin.

During the progress of the descending stream, it would often fall into some fissure, and forcing itself into apertures, and under massive rocks, and even hillocks and extended plats of ground, and lifting them from their ancient beds, bear them with all their superincumbent mass of soil, trees, etc., on its viscous and livid bosom, like a raft on the water. When the fused mass was sluggish, it had a gory appearance like clotted blood, and when it was active, it resembled fresh and clotted blood mingled and thrown into violent agitation. Sometimes the flowing lava would find a subterranean gallery diverging at right angles from the main channel, and pressing into it would flow off unobserved, till meeting with some obstruction in its dark passage, when, by its expansive force, it would raise the crust of the earth into a dome-like hill of fifteen or twenty feet in height, and then bursting this shell, pour itself out in a fiery torrent around. A man who was standing at a considerable distance from the main stream, and intensely gazing on the absorbing scene before him, found himself suddenly raised to the height of fifteen or twenty feet above the common level around him, and he had but just time to escape from his dangerous position, when the earth opened where he had stood, and a stream of fire gushed out.[30]

The hill where the lava first appeared is called Arare, and is about six miles from Kilauea easterly in the dense forest. The natives say that the lava rose in this crater about three hundred feet, and then sunk again when the fissure opened below, and in 1865 at the time of the author's visit there were evident proofs of this on the crater walls. The course of the stream seems to have led through a high hill (seen in the sketch of Makaopuhi) thus just avoiding this large pit where it might be supposed the resistance would be least, but the hill was probably hollow, being a cone from which the lava had been emptied, and the cavity beneath it perhaps exceeded in size the pit crater.

The elevation of the place where the lava finally reached the surface is given by Wilkes at 1244 feet, and it is twenty-seven miles from Kilauea, twenty-one from the first outbreak, and twelve from the shore at Nanawale. The sand-hills thrown up at this place were found to be one hundred and fifty, and two hundred and fifty feet high eight months after their formation, but since then the sea has removed the whole mass. Even in 1865 they were not a third of the measured height and nodules of olivine were abundant in the sands of the beach at considerable distance.

In November, 1840, when first visited by Professor Dana, the lava was still hot in many places, a few feet below the surface. Small sulphur banks, with deposits of alum and other salts were met with in several places.[31]

The lava of this eruption is chrysolitic to a marked degree; no such lava is found in Kilauea at present; such lava has issued in several streams from Mauna Kea in ancient times, also perhaps from Mauna Loa, if we suppose the large deposits of this lava occasionally found along the coast near Hilo to have proceeded from this mountain, and it is common in the old flows near Honolulu, and in later flows from Mauna Loa, in Kau. In the crater of Kilauea the olivine is in much smaller particles.

---

[30] Missionary Herald, vol. xxxvii, p. 283.

[31] Geology of the United States Exploring Expedition, p. 190.

In November of the same year, when visited by Dana, the lava had fallen three hundred and forty feet below the black ledge, or nearly a thousand feet below the highest wall, and only three pools of lava were in action. Halemaumau was fifteen hundred feet long and a thousand feet wide. The black ledge, three hundred and forty feet from the bottom, was from one to three thousand feet wide, and extended completely around the crater. No flames were visible, and there was but little noise.[32]

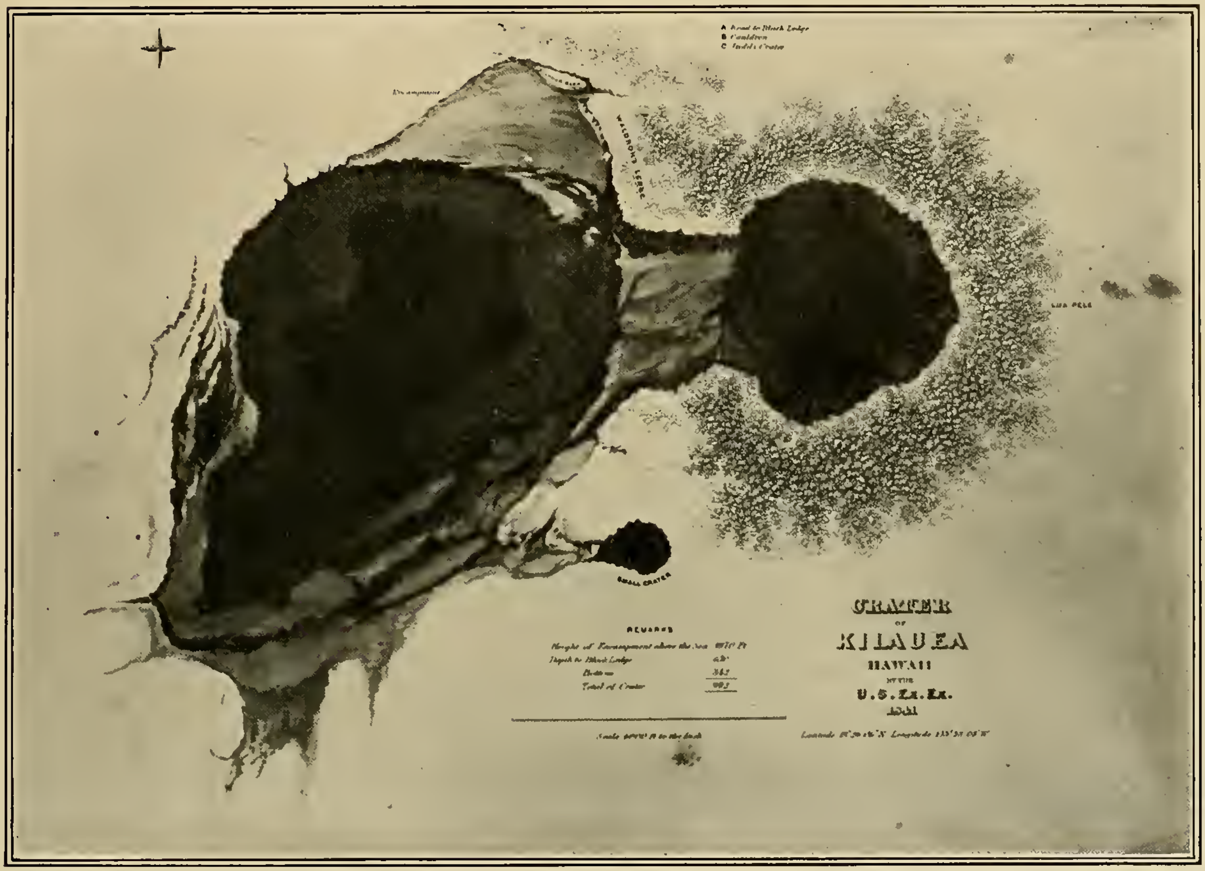

Encampment
WALDRON'S LEDGE
LUA PELE
SMALL CRATER
REMARKS
Height of Encampment above the Sea
Depth to Black Ledge
Bottom
342
Total of Crater
CRATER
OF
KILAUEA
HAWAII
BY THE
U.S.Ex.Ex.
1841
Latitude
Longitude

FIG. 44. THE WILKES PLAN OF KILAUEA IN 1841.

Unfortunately at the time of Dana's first visit (also at his second in 1887), Kilauea was not in a spectacular condition and he is rather inclined, not unnaturally, in his treatment of the vivid accounts of his predecessors to regard these as rather exaggerated, hence it is pleasing to find in his latest work the following description:[33] "In a night scene from the summit, the large cauldron in place of a bloody glare, now glowed with intense brilliancy, and the surface sparkled all over with shifting points of dazzling light, like a network of lightning, occasioned by the jets in constant play." My old friend, Dr. Charles Pickering, Dana's companion on the exploration, gave him the apt comparison to lightning, and Dana admits that Pickering was "a man of very exact observation and measured words."

---

[32] *Loc. cit.*, p. 171.

[33] Characteristics of Volcanoes, p. 68.

1841 In January, 1841, Dr. Pickering describes several considerable variations in the surface of Halemaumau, a hundred feet or more. On January 17, two of the pools discharged large quantities of lava over the bottom of the pit. The plan of the crater published by Wilkes, as well as the view by Drayton, one of the artists of the expedition, show the appearance of Kilauea at this time[34] (Figs. 44, 45).

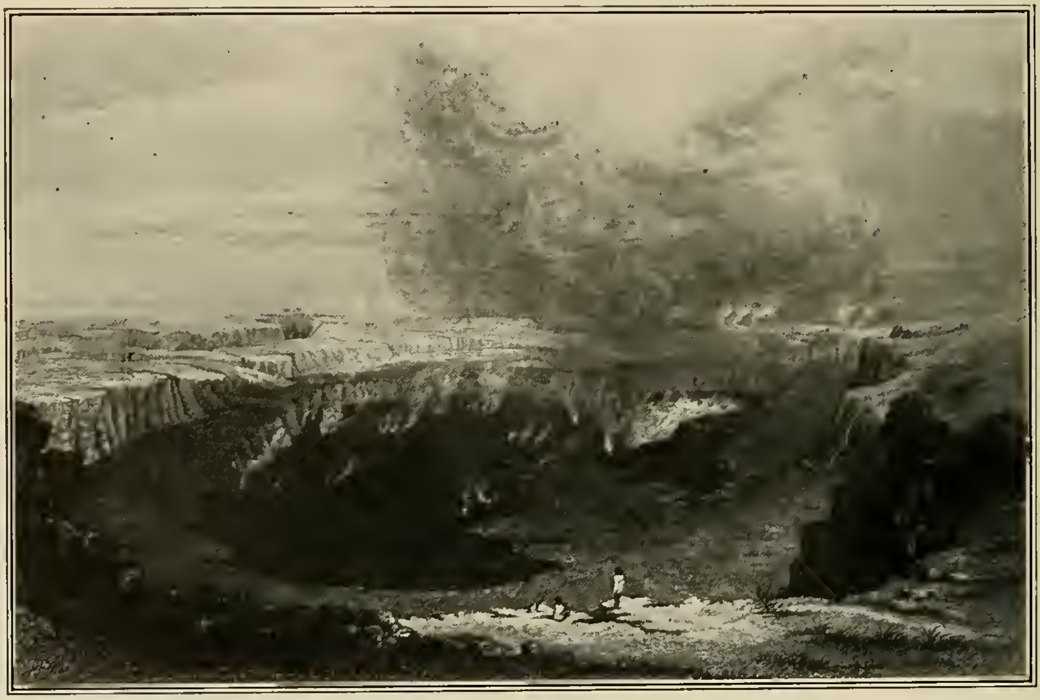


FIG. 45. DRAYTON'S VIEW OF KILAUEA IN 1841.

I do not quote much from the narrative of the United States Exploring Expedition, as Captain Wilkes included much in his story that was of merely personal interest; but there are a few statements about the condition of Kilauea at this time that should be noticed; and also, as the crater is generally such an amenable subject that accidents are almost unknown there, and "narrow escapes" seldom occur, it may be well to tell of one that actually occurred. I quote from the published report,[35] although I have heard the substance from Dr. G. P. Judd, who was Wilkes' most useful guide as well as friend. He was in the crater to obtain specimens for the expedition: he had collected gases and was trying to get at the liquid lava:

---

[34] Narrative of the United States Exploring Expedition, vol. iv, p. 178.

[35] Narrative U. S. Ex. Ex., vol. iv, p. 184, 4to ed. [434]

Dr. Judd then sought for a place where he might dip up some of the recent and yet fluid lava, but found none sufficiently liquid for the purpose. Failing here he proceeded toward the great fiery lake at the southern extremity of the crater. He found that the ascent toward this was rapid because the successive flowings of the lava had formed crusts which lapped over each other [see the formation in Pls. L and LII]. This rock was so dark in colour as to be almost black, and so hot as to act upon spittle just as iron, heated nearly to redness, would have done······At this time they were very near the great lake but could not see its surface, which was still about twenty feet higher than the spot where they stood······On his return the party passed the small crater which has been spoken of: and which by comparison with the larger one appeared cool. Smoke and a little igneous matter were issuing from a small cone in the centre: but with this exception, a crust of solid lava covered the bottom.

On the sides of this crater Dr. Judd saw some fine specimens of capillary glass, "Pele's hair," which he was anxious to obtain for our collection. He therefore, by the aid of the hand of one of the natives, descended and began to collect specimens. When fairly down he was in danger of falling, in consequence of the narrowness of the footing: but in spite of this difficulty, his anxiety to collect the best specimens enticed him onwards. While thus advancing, he saw and heard a slight movement in the lava about fifty feet from him, which was twice repeated, and curiosity led him to turn to approach the place where the motion occurred. In an instant the crust was broken asunder by a terrific heave, and a jet of molten lava full fifteen feet in diameter rose to a height of about forty-five feet, with a most appalling noise. He instantly turned for the purpose of escaping: but found that he was now under a projecting ledge which opposed his ascent, and that the place where he had descended was some feet distant. The heat was already too great to permit him to turn his face towards it, and was every moment increasing, while the violence of the throes, which shook the rock beneath his feet, augmented. Although he considered his life as lost, he did not omit the means for preserving it, but offering a mental prayer for the Divine aid, he strove, although in vain to scale the projecting rock. While thus engaged he called in English upon his native attendants for aid: and looking upwards, saw the friendly hand of Kalumo····extended towards him. Ere he could grasp it, the fiery jet again rose above their heads, and Kalumo shrank back scorched and terrified, until excited by a second appeal, he again stretched forth his hand, and seizing Dr. Judd's with a giant's grasp, their joint efforts placed him on the ledge······In looking for the natives they were seen some hundreds of yards distant running as fast as their legs could carry them. On his calling to them, however, they returned······Dr. Judd now found that he had no time to lose, for the lava was flowing so rapidly to the north, that their retreat might be cut off, and the whole party be destroyed. They therefore at once took leave of the spot and only effected their escape by running. ····The crater had previously been measured by Dr. Judd and was found to be thirty-eight feet deep by two hundred feet in diameter. The rapidity of its filling (in twelve minutes) will give some idea of the quantity of the fluid mass.

In February, 1842, Mr. Coan writes as follows:

When within four or five rods of the great lake, unaware of our near proximity to it, we saw directly before us a vast area of what we had supposed to be solid lava moving off to the right and left. We were at first a little startled, not knowing but all was about to float away beneath us, especially as the lavas for a mile back were almost insupportably hot, and gases and steam were escaping from numerous openings. On looking again, we perceived that the whole surface of the lake was from six to fifteen feet above the level of the surrounding lava, although at my last visit, it was from sixty to seventy feet below. Within six feet of this embankment we could see nothing of the lake, and in order to examine it we climbed the precipice some fifty feet. The explanation of this strange condition of things, is this: when the liquid contents of the lake had risen to a level with the brim, there was a constant and gradual boiling over of

1842

the viscid mass, but in quantities too small to run off far. Consequently it solidified on the margin, and thus formed the high rim which confined the lavas. Twice or at two points while we were there, the liquid flood broke through the rim, and flowed off in a broad, deep channel which continued its flow until we left the volcano. The view was a new one, and thrilling beyond description.

In July, 1844, Mr. Coan saw the large lake overflow on every side, spreading over the whole southern end of the crater to the base of the black ledge and concealing the outlines of the raised rim. Two deep fissures extended under the ledge nearly encircling that part of the crater, and one of these was one hundred feet deep. The diagram given in Mr. Coan's letter **1844** (which has not been published in full) is here reproduced as rendering clearer the geography at the time. Dana considers the canals as mysteries, but the explanation he gives (Characteristics of Volcanoes, p. 77) only substitutes one mystery for another. We will continue the record and overtake his explanation.

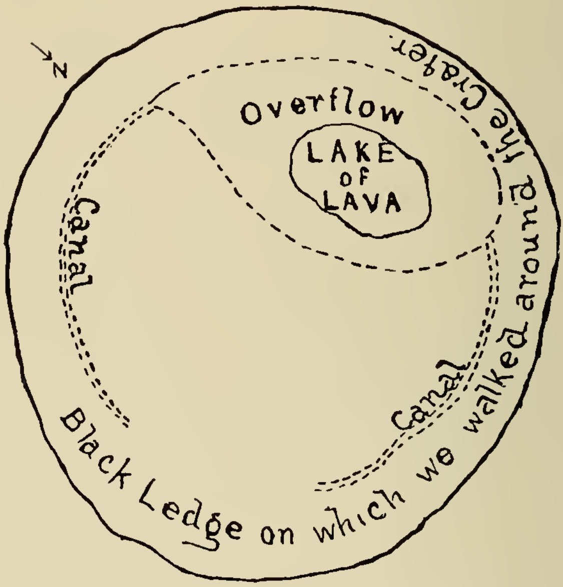


FIG. 46. DIAGRAM IN THE COAN LETTER.

In June, 1846, Mr. Coan writes[36] **1846** that "the repeated overflowings had elevated the central parts of the crater four or five hundred feet since 1840, so that some points are now more elevated than the black ledge." We may note that the rise in the floor level was due, according to this practised observer, to the overflow of the lake which filled up the lower levels, including the canals. A month later Rev. Chester S. Lyman was at the crater and found it much as the last observer had reported. The canal was nearly filled by overflows, and in places nearly obliterated.[37]

A rude sketch which Mr. Lyman left on the islands is here reproduced, and with this chart we may understand the explanation of the rapid rise of the bottom of Kilauea given by Mr. Lyman and adopted by Prof. Dana.[38] A crescent shaped ridge of rocks is shown on this sketch, and Lyman states that it was a continuous ridge more than a mile long, consisting of angular blocks of compact lava resembling the debris at the foot of a range of trap or basalt. From this he infers that the ridge once constituted a *talus* or accumulation of debris on the floor of the walls of the lower pit of 1840:

---

[36] Amer. Journ. Science, 1850, x, 361.

[37] Amer. Journ. Science, 1851, xii, 75.

[38] Prof. Lyman's plan, as given by Dana (Characteristics of Volcanoes, p. 79), is quite different from the plan he left on the spot and which is copied above. It must have been elaborated at New Haven from notes.

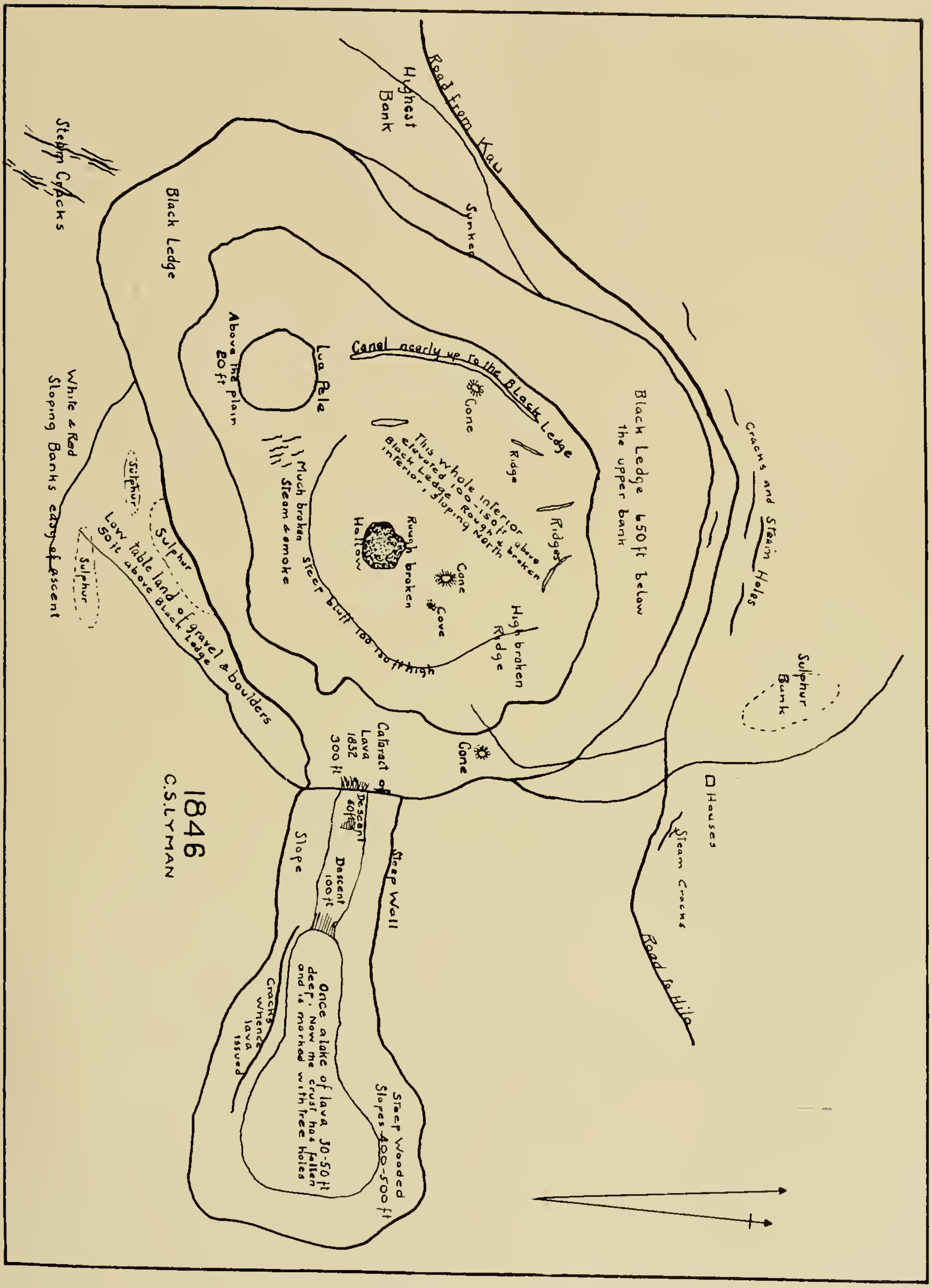

Road from Kau
Highest Bank
Synkee
Steam Cracks
Black Ledge
Cracks and Steam Holes
Sulphur Bank
Houses
Steam Cracks
Road to Hilo
Black Ledge 650 ft below the upper bank
Canal nearly up to the Black Ledge
Cone
Ridge
Ridges
This whole interior elevated 100-150 ft above Black Ledge Rough & broken interior, sloping North
High broken Ridge
Cone
Cove
Rough broken
Hollow
Steep bluff 100 to 150 ft high
Lua Pele
Above the plain 20 ft
Much broken Steam & smoke
Cone
Cataract of Lava 1832 300 ft
Descent 60 ft
Descent 100 ft
Steep Wall
Slope
Steep Wooded Slopes 400-500 ft
Once a lake of lava 30-50 ft deep. Now the crust has fallen and is marked with tree holes
Cracks whence lava issued
Sulphur
Sulphur
Sulphur
Low table land of gravel & boulders 50 ft above Black Ledge
White & Red Sloping Banks easy of ascent
1846
C.S.LYMAN

FIG. 47. LYMAN'S PLAN OF KILAUEA IN 1846.

that the floor with its margin of blocks had been elevated partly by upheaving forces from beneath, and partly by overflows from the Great Lake and other active vents until the talus overtopped the precipice at the foot of which it was accumulated. If these gentlemen had been content with either the elevation or the overflow theory singly, we could understand to some extent the process; we have recently seen the former in the strange obelisk of Mont Pelée, and the latter is the usual way in which the floor of Kilauea is raised. But if either Prof. Dana or Mr. Lyman had seen a lava stream taking a dry stone wall in hand, quietly insinuating its flexible black fingers under and between the stones and raising them up and carrying them off, they would have seen the improbability of their wall of stone remaining *in situ* surrounding an overflowing vent of lava. Mr. Coan saw clearly that the rise of the floor of the crater was due mainly at least to the accumulation of overflowing lava; it was acrogenous, and not pushed up from below. The rise of a cylinder of lava a mile in diameter some two hundred feet would be remarkable, but with an overflowing bowl of lava more than a thousand feet in diameter in its very midst the phenomenon would be incomprehensible. It is also difficult to see what this ascension has to do with forming the canals. When I surveyed the crater eight or nine years after, most of this wall, which did not appear on the original plan as shown above, had disappeared, but in a like position were scattered stones which I could not believe had ever been *elevated* to their then position; they had dropped from the cliffs above—the outer walls—precisely as can be seen today on the trail into the crater huge rocks of the same formation which were hurled down in the earthquake of 1868.

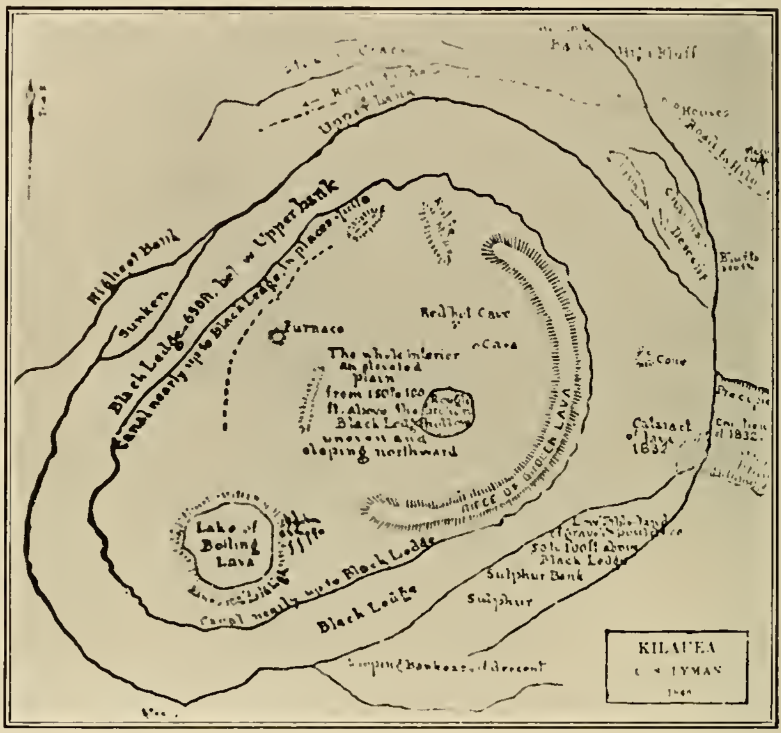

High Bluff
Houses
Road to Hilo
Upper Lava
Highest Bank
Sunken
Black Ledge 650 ft. below Upper bank
Canal nearly up to Black Ledge in places full
Furnace
Red hot Cave
Cave
The whole interior an elevated plain from 150 to 100 ft. above the Black Ledge uneven and sloping northward
Ridge of broken lava
Cone
Cataract of lava 1832
Precipice
Lake of Boiling Lava
Canal nearly up to Black Ledge
Black Ledge
Sulphur Bank
Sulphur
Sloping Banks easy of descent
KILAUEA
LYMAN

FIG. 48. LYMAN'S CORRECTED PLAN.

That there is a daily change of level in the dome-like floor of Kilauea, I cannot doubt. The black surface absorbs the heat of the sun to such a degree as at times to become unbearable to the touch. The casual visitor supposes this terrestrial heat, when it is really solar. The nights here are usually quite cold, and the change from midnight to noon must result in considerable expansion and contraction. In the early morning I have repeatedly heard the tinkling noise caused by the sun's rays on the cold lava as they displace the shadows of the cliffs; and I once measured the change in width of the great crack at the base of the dome on the trail across the crater, at eight inches between early morning and noon on a bright day. If we had a suitable observatory at Kilauea observations could easily be made all over the floor, and on the surface of Halemaumau as well for change of level.

But Mr. Lyman's visits, for he was again at Kilauea in August, were full of information. He saw a thick cone, marked "furnace" on his plan, in full blast on his second visit. Such a furnace as the writer saw in the summer of 1889. Lyman took a few compass bearings in the crater, and with an improvised quadrant obtained the height of walls. The Great Lake (Halemaumau) he made twenty-four hundred by two thousand feet, and the surface ten or fifteen feet below his standpoint on the rim. The lavas had an apparent motion to the southwest.

1847 Halemaumau was, according to Mr. Coan, much in the same condition as the previous year.[39]

1848 The lake was early in the year inactive, and the crust hardened and gradually assumed a convex form. Dana states that soon after this swelling crust two thousand feet in diameter, was raised into a dome two or three hundred feet high, covering the whole lake. Mr. Coan, from whom this information was obtained, adds that in August the dome was raised almost high enough to overtop the lower part of the outer wall of Kilauea and look out upon the surrounding country. From openings in the dome the molten lava could be seen, and occasionally sluggish lava rolled in heavy and irregular streams down the sides. The dome as it now stands has been formed by the compound action of upheaving forces from beneath and of eruptions from the openings forming successive layers upon its external surface. Most of this year no fires were to be seen even at night in Lua Pele.

This is the first appearance of a dome in the history of Kilauea, and it is hard to accept the elevation theory applied to a dome of the brittle nature of crust lava, cracked and fissured in every part, with such a vast diameter, holding together for any length of time even if its foundations were more solid than the brink of Halemaumau affords at its best. To suppose this raised two or three hundred feet without interior cross braces or supports is difficult: to suppose it blown up by gases, like a soap bubble, predicates a semifluid or elastic continuous crust which did not exist, for the dome was well punctured at its earliest formation and long before it attained its full height, the top was open like the dome of the Roman Pantheon, and from the lateral apertures flowed lava streams. I do not here dispute the fact that enormous masses have been pushed up to so great an height as five hundred feet from the molten or semi-molten pools in Kilauea,—we shall see many later,—but I must call attention to the difficulty of the problem.

---

[39] Amer. Journ. Science, 1851, xii, 80.

The dome continued to hold together over the quiet pit, like a mausoleum over a dead volcano, and in April, 1849, there came a change; activity was greatly increased; startling detonations were heard from cones around the dome, and from the opening on the top of this lavas were thrown fifty to sixty feet. Elsewhere in the main crater action was so violent as to frighten travelers from the descent to any part of **1849** Kilauea. This excitement did not last long, it suddenly ceased and Halemaumau was emptied of lava by subterranean discharge, in what direction is unknown, and there followed a period of great quiet. A period of what Mr. Coan aptly calls "steaming stupefaction" continued through the next two years, but early in 1852 boiling lavas could again be seen through the summit aperture of the dome, now one hundred feet in diameter. In July Mr. Coan writes[40] that the orifice had doubled its diameter, which constantly increased by the fall of fragments into the molten pool one hundred and fifty feet below. In the west wall of the dome was a crack from top to bottom, through which lavas were ejected, while vapors escaped from the perforated dome on all sides. In a later letter Mr. Coan writes[41] that at the beginning of 1854 the dome still stood, probably two miles in circumference and three to six hundred feet high. The surface of the main crater floor continued to rise and he estimated it at six hundred feet above the level of 1840.

We are now approaching a period when Pele's activity seems transferred from her everlasting house to her more lofty abode on Mauna Loa, and we can conveniently turn to that grand dome rising ten thousand feet above Kilauea. Henceforth we will record both mountains together, not that I believe they have any more connection than Kea and Hualalai, but for convenience of narrative, as the one in action attracts all the attention; but while Kilauea is generally visited whenever Loa is in action, Kilauea is frequently visited and always now has some one living on the banks, while Loa is seldom ascended, and in the winter season is difficult and even dangerous to ascend. In the winter or rainy months most of the eruptions of Loa have occurred.

---

[40] Amer. Journ. Science, 1853, xv. 63. Letter dated July 31, 1852.

[41] Ibid, 1854, xviii, 96. Letter dated Jan. 30, 1854. [440]

We must retrace our steps to the first recorded eruption of Mauna Loa in 1832. It is strange that no traditions of the natives point definitely to any previous one. They might have seen the fires from the summit crater Mokuaweoweo, or even the fire fountains from the cracks on the flanks, but even the hunters did not care to venture into the elevated waste where cold and winds and rain divided the realm with **1832** gods and wandering spirits of lower degree and even less morals. All that concerned the aborigines was the descent of a destroying lava stream into their fertile fields or over the sand beaches and into the bays, so important to a fishing population. The impelling spirit was always Pele, and from which of her many abodes she came mattered little to these children of Nature.

On June 20, 1832, Mauna Loa began to eject lava from the summit on several sides, and continued three or four weeks, with such brilliancy as to be visible at Lahaina, more than a hundred miles distant.[42] As no one ascended the mountain it is not known whether this eruption was from Mokuaweoweo or from some of the many vents dotted over the broad flat summit. Through the summer earthquakes were frequent on Hawaii, although not severe, and finally Kilauea burst into activity as described in the account of that volcano (p. 46).

After an interval of eleven years Mokuaweoweo again broke out. In 1837 Douglas made the first ascent of Loa by a foreigner (if not by any human being), and unfortunately wrote a letter to Dr. Hooker of Kew, England, in which he gives a wild and impossible account of the condition of the crater. In his journal, and in a later letter to Captain Sabine he gave a sane account of the crater which was quiescent.[43] **1843** He remarks that there was little in the upper part of the mountain to interest a naturalist. Mr. Douglas was all the time a botanist. The Wilkes expedition made the ascent in January, 1841, and found no activity beyond a few steam exhalations. Lieutenant Eld, by taking angles from the bottom of the crater, made the western wall 784 feet high, and the eastern 470 feet. Dr. G. P. Judd accompanied Eld in the descent into the crater. The accounts of the eruption of 1843 are as follows, the first from Dr. Andrews in a letter dated February 6, 1843:

> Smoke was first seen near the summit of the mountain, on Monday, January 9th. During the succeeding night a brilliant light was emitted from the same spot. The great distance of the mountain from Hilo—about forty miles—prevented our seeing anything more than the intense glare

---

[42] Amer. Journ. Science, xxv, 199.

[43] Dana says in a note on page 59 of his Characteristics of Volcanoes, in speaking of the letter to Dr. Hooker, which caused an unjust doubt to fall on all his reports, "His words indicate a mixing up and magnifying of what he had seen at the Kilauea and Mauna Loa craters, which can be explained only on the ground of temporary hallucination. He may have dined that day with his friend the British consul. Mr. Douglas was an excellent Scotchman, and all the rest of his writings are beyond questioning." The journal appeared in the Companion of the Botanical Magazine, ii, 79-182, in 1836. In the Journal of the Royal Geographical Society, 1834, iv, 333, is an important letter to Captain Sabine, and in the Magazine of Zoology and Botany, 1837, i, 582, are extracts from his journal including the letter to Dr. Hooker.

> sent forth by the boiling mass, which apparently was pouring forth and rolling down the side. . . During the day vast volumes of smoke were constantly pouring forth, concealing everything beneath. At times the smoke rose in a nearly perpendicular column, not less, as I judged, than one or two thousand feet high. Before the close of the week the light disappeared from the upper part of the mountain, and broke out anew near its base in the valley between it and Mauna Kea.[44]

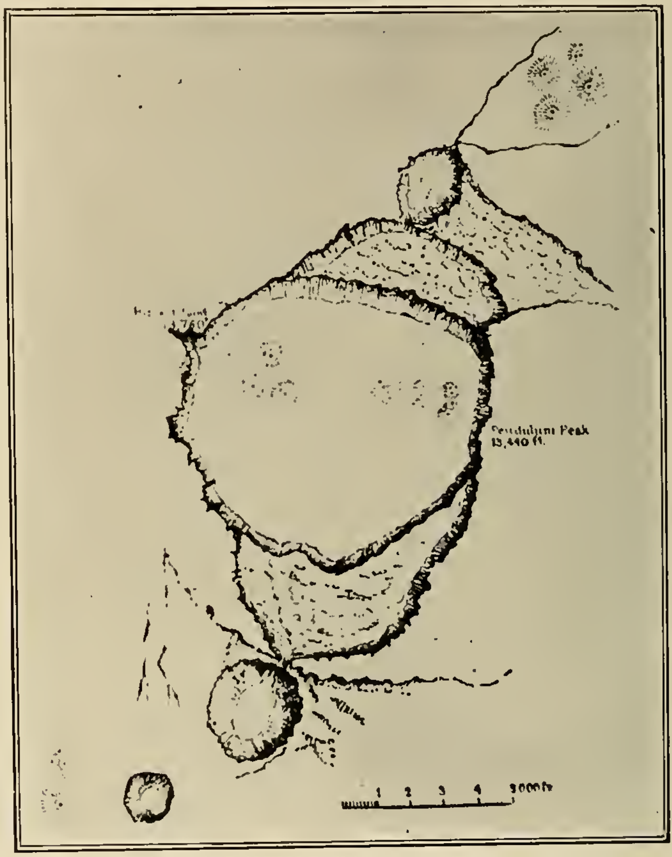


FIG. 49. WILKES' SURVEY OF MOKUAWEOWEO, 1841.

The Rev. Titus Coan writes under date of February 20, 1843.[45] After describing the brilliancy of the light he says: "For about four weeks this scene continued without much abatement. At the present time, after six weeks, the action of the fire is greatly diminished, though it is still somewhat vehement at one or two points along the line of eruption. The flow of the lava has probably extended twenty miles." Soon after this he was able to visit the scene of eruption, and ascend the mountain, and writes in a letter dated April 5: "The eruption has flowed from the summit of Mauna Loa to the base of Mauna Kea, where it separates into two broad streams, one flowing toward Waimea, and the other towards Hilo. Another great stream has flowed along the base of Mauna Loa towards Mauna Hualalai in Kona. These streams are still flowing, and they have reached a distance of from twenty-five to thirty miles from the crater on the top of the mountain. The quantity of lava is immense, it being many miles wide. There are two great active craters in close contiguity near the summit. Lava does not flow from these craters now; it is conveyed down the side of the mountain in a subterranean duct from fifty to a hundred feet below the surface, at the rate of from fifteen to twenty miles an hour."[46] Soon after this visit the flow ceased. Mr. Coan threw stones into the stream as it appeared through the openings in the crust, and they did not sink but were instantly carried along out of sight. Mounds, ridges and cones were thrown up along the lava stream, and from the latter, steam, gases and hot stones were ejected. The angle of descent for the whole distance is 6°, but in many places the stream was continuous at an inclination of 25°. Kilauea was visited by Mr. Abner Wilcox during this eruption, but it showed no signs of sympathy with the summit crater.

---

[44] Missionary Herald, xxxix, p. 381. [45] Ibid, 463. [46] Missionary Herald, xl. 44.

1849 In May, 1849, there was seen for two or three weeks a brilliant and lofty column of light over the mountain. Mr. Coan, who furnishes this note, says nothing of any outflow of lava or earthquakes.[47] **1851** In 1851 a slight eruption occurred on the summit of Mauna Loa, described by Mr. Coan as follows:[48] "On the 8th of August last a new eruption was seen on the western slope of Mauna Loa, a few miles from its summit. All we could see at Hilo was a white pillar of smoke by day and a brilliant fiery pillar by night....At Kau the view was less obstructed....The eruption continued but three or four days." This eruption broke out about a thousand feet below the summit, or two hundred feet below the bottom of the terminal crater. Some observers declare that the smoke proceeded partly from Mokuaweoweo, but no one ascended the mountain. No jets were thrown up and the fissure soon closed. From the portion of this stream that I visited in 1864, I should estimate its dimensions at ten miles in length, but less than a mile in average breadth, or in volume one hundred and sixty million cubic yards of lava. The greater part of this lava is pahoehoe, although some aa occurs, and the whole flow bears marks of rapid cooling. It followed very nearly the track of an eruption which broke down the western rim of Mokuaweoweo and flowed through Kealakeakua.

1852 February 17, 1852, only six months after the slight eruption just mentioned, Mauna Loa again broke out and our faithful chronicler writes as follows:[49]

> Old Kilauea has been quite tame since I last wrote you......At half-past three on the morning of the 17th ult. a small beacon light was discovered on the summit of Mauna Loa. At first it appeared like a solitary star resting on the apex of the mountain. In a few minutes its light increased and shone like a rising moon. Seamen keeping watch on deck in our port exclaimed, "What is that? The moon is rising in the West!" In fifteen minutes the problem was solved. A flood of fire burst out of the mountain, and soon began to flow in a brilliant current down its northern slope. It was from the same point, and it flowed in the same line, as the great eruption which I visited in March, 1843. In a short time immense columns of burning lava shot up heavenward to the height of three or four hundred feet, flooding the summit of the mountain with light, and gilding the firmament with its radiance. Streams of light came pouring down the mountain, flashing through our windows, and lighting up our apartments so that we could see to read large print. When we first awoke, so dazzling was the glare on our windows that we supposed that some building near us must be on fire; but as the light shone directly upon our couch and into our faces we soon perceived the cause. In two hours the molten stream had rolled, as we judged, about fifteen miles down the side of the mountain. This eruption was one of terrible activity and surpassing splendor, but it was short. In about twenty-four hours all traces of it seemed to be extinguished.

---

[47] American Journal of Science, 1851, xii, 82. Letter dated January, 1851.

[48] Ibid, xi, 395. A letter to Rev. C. S. Lyman.

[49] Ibid, xii, 219.

At daybreak on the 20th of February, we were again startled by a rapid eruption bursting out laterally on the side of the mountain facing Hilo, and about midway from the base to the summit of the mountain. This lateral crater was equally active with the one on the summit, and in a short time we perceived the molten river flowing from its orifice direct towards Hilo. The action became more and more fierce from hour to hour. Floods of lava poured out of the mountain's side, and the glowing river soon reached the woods at the base of the mountain, a distance of twenty miles.

Clouds of smoke ascended and hung like a vast canopy over the mountain, or rolled off on the wings of the wind. These clouds assumed various hues,—murky, blue, white, purple or scarlet—as they were more or less illuminated from the fiery abyss below. Sometimes they resembled an *inverted* burning mountain with its apex pointing to the awful orifice over which it hung. Sometimes the glowing pillar would shoot up vertically for several degrees, and then describing a graceful curve, sweep off horizontally, like the tail of a comet, further than the eye could reach. The sable atmosphere of Hilo assumed a lurid appearance, and the sun's rays fell upon us with a yellow, sickly light. Clouds of smoke careered over the ocean, carrying with them ashes, cinders, charred leaves, etc., which fell in showers upon the decks of ships approaching our coast. The light was seen more than a hundred miles at sea, and at times the purple tinge was so widely diffused as to appear like the whole firmament on fire. Ashes and capillary vitrifactions called Pele's hair fell thick in our streets and upon the roofs of our houses. And this state of things still continues, for even now while I write, the atmosphere is in the same yellow and dingy condition; every object looks pale, and sickly showers of vitreous filaments are falling around us, and our children are gathering them.

As soon as the second eruption broke out I determined to visit it. Dr. Wetmore agreeing to accompany me, we procured four natives to carry our baggage, one of them, Kekai acting as guide. On Monday the 23rd of February, we all set off and slept in the outskirts of the great forest which separates Hilo from the mountains. Our track was not the one I took in 1843, namely the bed of a river; we attempted to penetrate the thicket at another point, our general course bearing southwest. In ancient days an Indian trail had been beaten through in this direction, but it was now entangled with jungle so that all traces of it were nearly obliterated. However, we plunged into the forest with a long knife, hatchet and clubs, and cut and beat our way at the rate of one and a fifth miles an hour. At night we slept in the bush and listened to the distant roar of the volcano. On Wednesday the 25th we gained a little eminence in the woods, from which we could see the lava-stream which was now opposite us on our left, distant six miles. This fiery flood was now half way through the forest, and more than three-fourths of the way from the crater to the shore, sweeping all before it. Apprehending that it might reach the sea in a day or two, and that the ladies at the station might be alarmed, Dr. Wetmore determined to return. Taking one of the natives and leaving three with me, he retraced his steps while I pushed on through jungle and bog and dell, beating every yard of my way out of this horrible thicket. On the 26th we emerged from the forest but plunged at once into a dense fog more dark than the thicket itself. Pushing up the mountain we encamped for the night on a rough bushy ridge. A little before sunset the fog rolled off, and Mauna Kea and Mauna Loa both stood out in grand relief; the former robed in a fleecy mantle almost to its base, and the latter belching out floods of fire from its burning bowels. All night long we could see the glowing fires, and listen to the awful roar of the fearful crater.

We had now been out four nights, and were within twenty miles of the crater, with the long brilliant river of fusion on our left shining in a line of light down the side of the mountain [see the illustration of the flow of 1887] till it entered the woods. We left our mountain aerie on the 27th, determined if possible to reach the seat of action on that day. Taking the pillar of fire and cloud as our mark, and still having the great river of lava on our left, we pushed on over a rough and almost impassable surface—the attraction increasing as the square of the distance decreased. Our intense interest mocked all obstacles. At noon we came upon the confines of a tract of naked scoriæ so intolerably sharp and jagged that our baggage-men could not pass it. Here I ordered a halt;

stationed the two carriers, gave an extra pair of strong shoes to my guide, gave him my wrapper and blanket, put a few crackers and boiled eggs into my pockets, took my compass and staff, and said to Mr. Salt Sea (Kekai), "Now go ahead, and let us warm ourselves tonight by that fire yonder." Thus equipped we pressed up the mountain, over fields of indescribable roughness; now mounting a ridge of sharp and vitreous scoriæ (aa), where the fiery pillar stood full in view, and then plunging into some awful ravine or pit, from which we slowly emerged by crawling upon all fours. But I soon found that my guide needed a leader. He was too slow. I therefore pressed ahead, leaving him to get on as best he could. After half-past three P. M. I reached the awful crater and stood alone in the light of its fires. It was a moment of unutterable interest. I seemed to be standing in the presence and before the throne of the eternal God; and while all other voices were hushed, His alone spake. I was ten thousand feet above the sea, in a vast solitude untrodden by the foot of man or beast; amidst a silence unbroken by any living voice, and surrounded by scenes of terrific desolation. Here I stood almost blinded by the insufferable brightness; almost deafened by the startling clangor; almost petrified with the awful scene. The heat was so intense that the crater could not be approached within forty or fifty yards on the windward side, and probably, not within two miles on the leeward. The eruption as before stated, commenced on the very summit of the mountain, but it would seem that the lateral pressure of the embowelled lava was so great as to force itself out at a weaker point in the side of the mountain; at the same time cracking and rending the mountain all the way down from the summit to the place of ejection......The eruption first issued from a depression in the mountain, but a rim of scoriæ two hundred feet in elevation had already been formed around the orifice in the form of a hollow, truncated cone. This cone was about half a mile in circumference at its base, and the orifice at the top may be three hundred feet in diameter...... The eruptions were not intermittent but continuous. Volumes of the fusion were constantly ascending and descending like a *jet d'eau*. The force which expelled these igneous columns from the orifice, shivered them into millions of fragments of unequal size, some of which would be rising, some falling, some shooting off laterally, others describing graceful curves; some moving in tangents, and some falling back in vertical lines into the mouth of the crater. During the night the scene surpassed all powers of description. Vast volumes of lava, at a white heat shot up continuously...A large fissure opening through the lower rim of the crater gave vent to the molten flood which constantly poured out of the orifice and rolled down the mountain in a deep, broad river at the rate, probably, of ten miles an hour.

The stream stopped about ten miles from Hilo beach; the eruption lasted twenty days. Early in March Messrs. H. Kinney and Fuller made the ascent and they confirm Mr. Coan's description of the terrific noise, but are inclined to enlarge his estimates in some particulars. Mr. Kinney made the height of the jets four to eight hundred feet: he noticed great whirlwinds about the jet, stalking like sentinels. Mr. Fuller states[50] that the diameter of the crater from which the jets played was about a thousand feet; height of crater, a hundred to a hundred and fifty feet; height of the jet, two to seven hundred feet, and rarely below three hundred feet; diameter of the jet, one to three hundred feet, and rarely perhaps reaching four hundred feet. In July Mr. Coan again ascended to the crater and found no fire. He found an unusual supply of limu or basaltic pumice. He says in writing of this, "We found it ten miles from the crater, and it grew more and more abundant till we reached the cone, where it covered the whole region to a depth of five or ten feet.[51]

---

[50] American Journal of Science, 1852, xiv, 258. Letter dated Waiohinu, March 28.

All this time Kilauea was quiet and remained so all through 1854, but the next year the old activity returned. Underneath the dome the lava was throwing up jets to the height of perhaps two hundred feet; vents had opened around the edge of the floor of the main crater, and Mr. Coan, in May and June, could count sixty lakes of leaping lavas. There was one great pool in the northeast region near where **1855** the path meets the bottom, and other boiling cauldrons not far distant, so that access to the crater was cut off.[52] On July 6th Dr. Titus Munson Coan was at the crater, and found this northeast pool crusted over except at the edge where the lavas were splashing. Halemaumau was estimated to measure four hundred by two hundred and fifty feet in its diameters, while the lava was seventy-five feet below the rim. The walls of this pit were tufted with Pele's hair, and two islands were in the northwest part of the lake. In October the crater was still active, but less so than early in the summer. The dome over Halemaumau had fallen in. It is thought that the lavas had passed out as at the last so-called eruption in 1849. But there was more important work going on in the Hawaiian lava ducts.

In a letter dated September 27, 1855, Mr. Coan writes: "On the evening of the eleventh of August, a small point glowing like Sirius, was seen at the height of twelve thousand feet on the northwestern slope of Mauna Loa. This radiant point rapidly expanded, throwing off corruscations of light, until it looked like a full-orbed sun."[53]

Sixty-five days later, the fissure which permitted the escape of lava was still open and in awful activity. The stream was flowing directly towards Hilo and there were no valleys or ridges of sufficient size to turn its course. The inhabitants of this beautiful village were exceedingly anxious, and made frequent excursions to the scene of the lava-flow. On the second of October, Mr. Coan with a party of friends passed through the thick forest, following the course of the Wailuku river, and on the fifth reached the lava-stream early in the morning, at a narrow point where it was about three miles wide. "In some places it spread out into wide lakes and seas, apparently from five to eight miles broad, enclosing, as is usually the case, little islands not flooded by the fusion." Mr. Coan continues in this letter, which is dated October 15, 1855:[54]

> Early on Saturday, the 6th, we were ascending our rugged pathway, amidst steam and smoke and heat which almost blinded and scathed us. At ten we came to open orifices down which we looked into the fiery river which rushed furiously beneath our feet. Up to this we had come to no open lake or stream of active fusion. We had seen in the night many lights, like street lamps, glowing along the slope of the mountain at considerable distances from each other, while the stream made

---

[51] American Journal of Science, 1853, xv, 63.

[52] Ibid, 1856, xxi, 100, 139.

[53] Ibid, xxi, 144.

[54] Ibid, 139.

its way in a subterranean channel, traced only by these vents. From 10 A.M. and onward, these fiery vents were frequent, some of them measuring ten, twenty, fifty, or one hundred feet in diameter. In one place only we saw the river uncovered for thirty rods and rushing down a declivity of from ten to twenty-five degrees. The scene was awful, the momentum incredible, the fusion perfect (a white heat), and the velocity forty miles an hour. The banks on each side of this stream were red-hot, jagged and overhanging, adorned with burning stalactites and festooned with immense quantities of filamentose or capillary glass, called Pele's hair. From this point to the summit crater all was inexpressibly interesting.

Valve after valve opened as we went up, out of which issued fire and smoke and brimstone, and down which we looked as into the caverns of Pluto. The gases were so pungent that we had to use the greatest caution, approaching a stream or an orifice on the windward side, and watching every change or gyration of the breeze. Sometimes whirlwinds would sweep along loaded with deadly gases, and threatening the unwary traveler. After a hot and weary struggle over smoking masses of jagged scoriæ and slag, thrown in wild confusion into hills, cones and ridges, and spread out over vast fields, we came at one P.M. to the terminal or summit crater (not Mokuaweoweo).

This we found to be a low elongated cone, or rather a series of cones, standing over a great fissure in the mountain. Mounting to the crest of the highest cone, we expected to look down into a great sea of raging lavas, but instead of this the throat of the crater, at the depth of one hundred feet was clogged with scoriæ, cinders, and ashes through which the smoke and gases rushed up furiously from seams and holes. One orifice within this cone was about twenty feet in diameter, and was continually sending up a dense column of blue and white smoke which rolled off in gases and spread over all that part of the mountain, darkening the sun and obscuring every object a few rods distant. So toppling was the crest of this cone, so great the heat, and so deadly the gases, that we could find no position where we could look down the throat of the orifice; and could we have done so, it is not probable that we should have seen the deep fountain below us, as the lavas were forced up its horrid chimney from the burning bowels of the earth.

The summit cone which we ascended was about one hundred feet high, say five hundred feet long, and three hundred broad at its base. Several other cones below us were of the same form and general character, presenting the appearance of smoking tumuli along the upper slope of the mountain.... The molten stream first appears some ten miles below the fountain crater, and as we viewed it rushing out from beneath the black rocks, and, in the twinkling of an eye, diving again into its fiery den, it produced indescribable feelings of awe and dread. The summit crater I estimate at twelve thousand feet elevation; the principal stream (there are many lesser and lateral ones) including all its windings, sixty miles long; average breadth, three miles; depth from three to three hundred feet, according to the surface over which it flowed. The present eruption is between those of 1843 and 1852, and from our high tower we could see them both and trace their windings.

Early on Monday we decamped and set our faces for Kilauea, distant some thirty-five miles, hoping by a forced march to reach it at night. At eight A.M. we passed the seat of the grand eruption of 1852, and travelled for miles on its cinders. A little steam only issues from that cone whose awful throat in 1852, sent up a column of glowing fusion to the height of a thousand feet. We explored Kilauea and on Thursday reached Hilo.

Hilo is now in a state of solemn and thoughtful suspense. The great summit fountain is still playing with fearful energy and the devouring stream rushes madly down towards us. It is now about ten miles distant,—nearly through the woods, following the right bank of the Wailuku, and heading directly for our bay.

October 22. It is now seventy-two days since the eruption commenced, and the fountain is in full force. The matter disgorged is of the same general character as in former eruptions. We saw nothing new. Among the salts, sulphur and sulphate of lime are the most abundant. They are scattered freely at several points along the line of flow.

Mr. Coan, it will be seen, struck the flow at a point above the terminus and followed it to its source. On his return he determined to cut through the forest and meet the stream. Following a branch of the Wailuku in a drenching rain which made the river almost impassable, he thus describes the scene:[55]

> So soon as we entered this stream we found it discolored with pyroligneous acid from burning wood, whose odor and lustre became more and more positive the further we advanced up the stream. The discoloration also became more apparent as we proceeded, until the water was almost black. This showed that the lava-flow had crossed the head waters of the stream and its small tributaries, consuming the forest and jungle, and sending down what could not be evaporated of the juices to mingle with the stream.
>
> A little before sundown our guide led us at right angles from the stream we had been threading for six hours, and in a few minutes the fires of the volcano glared upon us through the woods. We were within six rods of the awful flood which was moving sullenly along on its mission towards Hilo. Thrusting our poles into the lava, we stirred it, and dipped it up like pitch, taking out the boiling mass, and cooling all the specimens we desired. We were on the right or southern verge of the stream, and we also found that we were about two miles above its terminus, where it was glowing with intense radiance and pushing its molten flood into the dense forest which still disputed its passage to the sea. We judged the stream to be two or three miles wide at this point, and over all this expanse, and as far as the eye could see above, and down to the end of the river, the whole surface was dotted with countless fires, both mineral and vegetable. Immense trees which had stood for hours, or for a day, in this molten sea, were falling before and below us, while the trunks of those previously prostrated were burning in great numbers upon the surface of the lava.
>
> You are aware that the great fire-vent on the mountain discharges its floods of incandescent minerals into a subterranean pipe which extends at a depth of from fifty to two hundred feet, down the side of the mountain. Under this arched passage the boiling lava hurries down with awful speed until it reaches the plains below. Here the fusion spreads out under a black surface of hardened lava some six or eight miles wide, depositing immense masses which stiffen and harden on the way. Channels, however, winding under this stratified stratum, conduct portions of the lava down to the terminus of the stream, some sixty-five miles from its high fountain. Here it pushes out from under its mural arch, exhibiting a fiery glow, across the whole breadth of the stream. Where the ground is not steep, and where the obstructions from trees, jungle, depressions, etc., are numerous, the progress is very slow, say one mile a week.
>
> On the evening of our arrival we encamped within ten feet of the flowing lava, and, as before stated, on the southern margin of the stream, some two miles above its extreme lower points. Here under a large tree, and on a bank elevated some three feet above the igneous flood which moved before us, we kept vigils until morning. During the whole night the scene was indescribably brilliant and terribly sublime. The greater portion of the vast area before us was of ebon blackness, and consisted of the hardened or smouldering flood which had been thrown out and deposited here in a depth of from ten feet to one hundred.
>
> Not only was the lava, as aforesaid, gushing out at the end of this layer, but also at its sides. These lateral gushings came out before and behind us, and two-thirds surrounded our camp during the night, so that in the morning, when we decamped, the fusion was just five feet by measurement, in front of us, six feet in our rear, and three feet, or the diameter of the trunk of our camp-tree, on our left. The drenching rain and our chilled condition induced us to keep as near the fire as we could bear it. Evening and morning we boiled our tea-kettle and fried our ham upon the melted lavas, and when we left, our sheltering tree was on fire.

---

[55] American Journal, xxi, 237. The letter is dated Nov. 16, 1855.

Mr. Coan made several attempts to cross the lava-flow, "but the hardened surface of the stream was swelling and heaving at innumerable points by the accumulating masses and the upraising pressure of the lava below; and valves were continually opening out of which the molten flood gushed and flowed in little streams on every side of us. Not a square rod could be found on all this wide expanse, where the glowing fusion could not be seen under our feet through holes and cracks in the superincumbent stratum on which we were walking. The open pots and pools and streams we avoided by a zigzag course; but as we advanced, these became more numerous and intensely active, and the heat becoming unendurable, we again beat a retreat after having proceeded some thirty rods upon the stream. It may seem strange to many, that one should venture on such a fiery stream at all, but you will understand that the greater part of the surface of the stream was hardened to the depth of from six inches to two or three feet; that the incandescent stream flowed nearly under this crust like water under ice, but showing up through ten thousand fissures and breaking up in countless pools. On the hardened parts we could walk, though the heat was almost scorching, and the smoke and gases suffocating. We could even tread on a fresh stream of lava only one hour after it had poured out from a boiling cauldron, so soon does the lava harden in contact with the air."

Although the stream of lava continued to move for more than a year after in parts of its course, its front became cold and fixed on the banks of the river, and a merciful Providence listened to the prayers of the people of Hilo.

Prof. Dana considered it most probable that a fissure had extended completely down the mountain side, and that the lava issued from many vents along this line.[56]

March 7, 1856, Mr. Coan writes:

> The great fire-fountain is still in eruption, and the terminus of the stream is only five miles from the shore. The lava moves slowly along on the surface of the ground, and at points where the quantity of lava is small, we dip it up with an iron spoon held in the hand. During the last three weeks the stream has made no progress toward Hilo, and we begin to hope that the supply at the summit-fountain has diminished. There is, however, still much smoke at the terminal crater. You will understand that the molten flood is all poured out of the fissures on the summit and for a few miles down the slope of the mountain. At first this disgorgement flowed down and spread wide on the surface of the mountain, as blood flows down a punctured limb. This phenomenon continued until the stream had swept down some thirty miles, which it did in about two days. It now came upon a place were the angle of slope was small, say one degree. Here its progress became slow, it spread more widely, and refrigeration was more rapid. The surface of course hardened first. But this refrigerating process went deeper and deeper like the congelation of water, and extended higher up the mountain, until at length all the lava was covered, except at occasional vents—as heretofore described—for the escape of steam and gases.
>
> The process of breaking up vertically and spreading out afresh upon the hardened crust, was occasioned by obstructions at the end of the stream, damming up the liquid, and thus obliging the accumulating lavas to force new passages and outlets for disgorgement. In this way the stream was

1856

---

[56] American Journal, xxi, 241.

> widened by lateral outgushings, divided into several channels, swayed to the right and left, and raised to great heights by pushing up from below and heaping mass after mass upon what *had been* its upper stratum. Often when the stream had been flowing briskly and brilliantly at the end, it would suddenly harden and cool, and for several days remain inactive. At length, however, immense areas of the solidified lava, four, five or six miles *above* the end of the stream, are seen in motion—cones are uncapped—domes crack—hills and ridges of scoriæ move and clink—immense slabs of lava are raised vertically or tilted in every direction, while a low sullen crash is heard from below. While you gaze in mute amazement, and feel the solid mass of rock, often thirty, fifty, or seventy feet thick, moving under your feet, the struggling lava oozes out through ten thousand orifices and fissures over a field of some four or five square miles. More than once have I been on such a field, and heard, and seen, and felt more than is here or can be described. And yet the action of the lava is so slow, in the conditions described, that there is no fear, and little danger to one well acquainted with such phenomena.
>
> During the night of the 29th of January, the molten stream poured continuously over a precipice of fifty feet, into a deep, dry basin half filled with flood-wood. The angle down which this fire cataract flowed, was about seventy-five degrees: the lava was divided into two, three, and sometimes four channels from one to four yards wide, and two or three feet deep. The flow was continuous down the face of this precipice from two P.M. until ten the next morning when we left. During the night the immense basin under the fall was filled, the precipice converted into an inclined plane of about four degrees, and the burning stream was urging its way along the rocky channel below. But the scene on the night of the 12th of February was, in some respects, more gorgeous still, as it combined the element of water with that of fire. A stream of lava from twenty to forty yards wide had followed the rocky and precipitous bed of a river, until it was two miles in advance of the main lava-flow, which was nearly two miles broad. Beating our way through the thicket we came upon the terminus of this narrow stream of lava, near sunset. It was intensely active, and about to pour over a precipice of thirty-nine feet (by measurement), into a basin of deep water, large enough to float a ship. Before dark the lava began to fall into the water, first in great broken masses, like clots of blood; but in a short time in continuous, incandescent streams, which increased from hour to hour in volume, in brilliancy, and in rate of motion. [See Plate XLI, which represents exactly similar action at a later period.] The water boiled and raged with fearful vehemence, raising its domes and cones of ebullition ten feet high, and reflecting the red masses of fusion like a sea of fire mingled with blood.
>
> We encamped on the bank of the river, about fifty feet below the fiery cataract, and exactly opposite the basin of water into which the lava was flowing, twenty feet only from its rim. The face of this precipice was an angle of about eighty degrees, and the lava flowed down it briskly and continuously in streams from one to four feet deep, during the night. Before morning this whole body of water, some twenty feet deep, was converted into steam, and the precipice became a gently inclined plane.

To make the fact that the fissure did not extend to the base of the mountain more clear, Mr. Coan again writes under date of October 22, 1856; he had then visited the flow seven times:

> A fracture or fractures occurred near the summit of the mountain, which extended in an irregular line from the terminal point, say five miles down the northeast slope of the mountain. From this serrated and yawning fissure, for two to thirty yards wide, the molten flood rushed out and spread laterally for four or five miles, filling the ravines, flowing over the plains, and covering all those high regions, from ten to one or two hundred feet deep. Along this extended fissure, elongated cones were formed at the points of the greatest activity. These cones appear as if split through their larger diameter, the inner sides being perpendicular or overhanging, jagged and hung with

stalactites, draped with filamentous vitrifications, and encrusted with sulphur, sulphate of lime and other salts. The outside of these cones are inclined planes, on an angle of forty to sixty degrees, and composed of pumice, cinder, volcanic sand, etc. You will not, however, understand that these semi-cones were once entire, and that they have been *rent*. They are simply masses or ridges of cinder and dross deposited on each side of the fractures where the action is greatest. *It is all a new deposit*. [See a similar cone painted by D. Howard Hitchcock in the eruption of 1899.] After you leave the region of open fissures, near the summit of the mountain, all below *appears to be a flow on the surface*.

1st. We can *see* no chasms or fractures except those always found in the surface flows. There is no visible evidence that the old substrata had been fractured except on the higher regions of the mountain.[57]

2d. Where there is a throat extending down to the fiery abyss below, there will, we think, always be a column of smoke and gaseous vapor ascending to mark the spot, so long as action continues. This is true of Kilauea, and it is also true of *all* the eruptions I have noticed. Now if you were at Hilo, you would see a continuous volume of smoke ascending from the terminal point, and another from the terminus of the stream—separated in a direct line forty miles, and by route of the flow seventy miles—while between these extreme points you see no smoke and have no evidence of fire beneath[58] except the radiation of heat as you pass up. The smoke at the fountain is mineral, that at the end of the stream is from vegetation, and only here the fusion now makes its appearance, having come, as I believe, all the way from the mountain under cover, without showing itself at a single point. I do not mean that it has tunnelled the mountain, or melted a lateral duct through its mural sides. The process is this: lavas flowing on the surface and exposed to the atmosphere, unless moving with great velocity, as down steep hills, soon refrigerate on the surface. This hardened surface thickens, until it extends downward from one to two hundred feet, as the case may be. Under this superstratum the lava remains liquid; consequently at the termini and sometimes along the margins of the hardened streams you see the fusion gushing out in lines and points, and in irregular masses. When lavas refrigerate through the whole stratum, and thus rest on an ancient or previous formation, they form dams which divert the stream of lava from above, unless this obstruction is broken up, tilted, or overflowed by fresh lava. Down the steep sides of the mountain such obstructions occur more rarely; consequently the lava ceases to reach the surface either at the fountain or down the sides of the mountain, but is confined to channels, mostly covered with fresh, solidified lavas, where it finds a free and rapid passage to the plains below. Here the movement is slow, the obstructions more numerous, and the force to overcome them less patent. This accounts for the spreading laterally, the upliftings, and the ten thousand irregularities which diversify the ever-changing surface of lava streams. I have seen a dome, some three hundred feet in diameter at base, raised one hundred feet high and split from the summit in numerous radii, through which the red and viscid fusion was seen; and I have mounted to the top of such a dome in this state, thrust my pole into the liquid fire and measured the thickness of its shell, which was from two to five feet. Wherever vegetable matter is being consumed there is smoke; when this is exhausted there is none. Consequently I argue that there are no fissures extending to the central fires of the earth, except for a few miles near the summit of the mountain.

3d. Again, and what is more reliable, I have surveyed the ground upon which lava-streams have been approaching, for distances of five to twenty miles, and have seen the burning flood move on, covering today the ground on which I traveled yesterday, and consuming the hut where I slept; and the process is so familiar that it is difficult to see how I can be mistaken. I *think* that this stream of lava is *now flowing* more than sixty miles longitudinally under its own refrigerated cover; but I may be mistaken. No fire is *seen* anywhere except at the end of the stream. Here it still pushes out and spreads and heaps with little abatement, while the great mountain furnace sends up large and continuous volumes of smoke.[59]

---

[57] A careful examination of the line of eruption resulted in the conviction that the fissure was originally very small, not exceeding three or four feet, and did not extend below the point where the lava first reached the surface.

[58] This has been the case for some eight months. At first the whole ridge of the mountain was lighted with fusion on the surface; afterwards no fire was seen except at the end of the stream near Hilo [Note by Mr. Coan].

To this exceedingly full and minute account, I need only add that I visited in 1865 the terminus of the stream, where it ceased to flow, and found the whole appearance of the stream in strict accordance with Mr. Coan's account. The surface was horribly rough and piled with slabs of hardened crust in vast ridges extending for miles. I slept on the fresh lava and examined the structure minutely, and found nothing to distinguish this stream from other eruptions, except its broken condition, arising from the wet soil over which it passed, which raised the surface into huge blisters. Where the lava fell into the water it was shivered into coarse sand like the deposit (known as "black sand") near Punchbowl in Honolulu, and as the water was evaporated the pahoehoe covered the ground almost entirely and even penetrated its mass. The angles down which the continuous stream of lava fell were as large as Mr. Coan mentions, and the lava does not seem much more cellular here than on level ground.

At the lowest edge of the lava-flow, I found, on the more ancient rock, rounded masses of red earth (ferruginous oxides) of the consistency of putty, and as large as a man's head. They were in considerable number, and seemed to have been pushed along by the lava; their softness was owing to the rain, as when dried they became as hard as dried potter's clay. The surface of the stream lava was covered with a minute lichen on which great numbers of succineas were feeding.

After flowing fifteen months this important eruption ceased. Professor Dana still thought the lava supply came from fissures along its track, but I cannot see any reason for this opinion. Mr. Coan and those who have followed in his steps are convinced of the contrary, and the *opinion* of an observer with such unequaled experience is worthy of great consideration. Those who have never seen a lava-flow, cannot well understand its action. I believe that Mr. Coan's briefest account conveys a better idea of what such a flow is than the most elaborate theorizing of those who have never seen one, or who see one for the first time.

In October, 1856, Mr. Coan reports Kilauea as declining in activity since the summit eruption began, there was but little sluggish lava in Halemauman, but much escaping vapor.[60] In June, 1857, Kilauea was still quiet.[61] The lava in Halemauman was a hundred feet below the brink and only five hundred feet across. In August, 1858, this pool "boiled and sputtered lazily at the centre of a deep basin which occupied the locality of the old dome. The action alternated between general refrigeration and a breaking up of the whole surface with intense ebullition."[62] In 1862 the lava pool had increased to six hundred feet in diameter. Within the central depression there was, a quarter of a mile from the pool, a driblet cone of remarkable form with turrets which Mr. Coan called the Cathedral, and which, two years after, I found a very convenient object in my survey of the crater, as it was visible from the entire outer rim. In October, 1863, Mr. Coan reported an awakening in Halemaumau and indeed all around the crater.[63] We must now look at Mauna Loa. A letter from Prof. R. C. Haskell, of Oahu College, gives the following account of the important eruption of 1859:[64]

---

[59] American Journal, xxiii, 435. [60] Ibid, 438. [61] Ibid, xxv, 136.

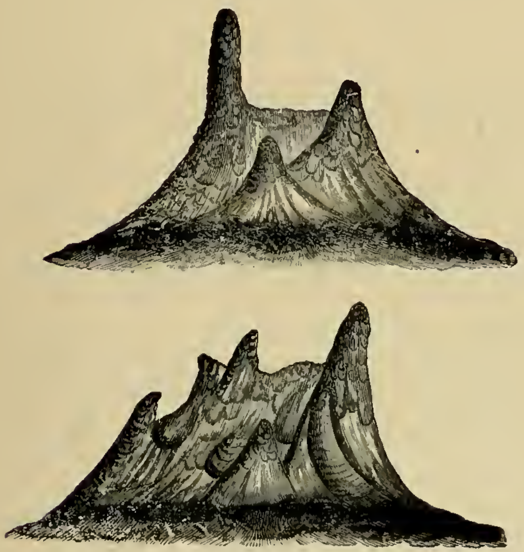


FIG. 50. THE CATHEDRAL FROM WEST AND NORTHWEST.

> Our party consisted of Prof. E. G. Beckwith, Prof. W. D. Alexander and myself, with some students of the college. The eruption broke out on the 23d of January. No earthquake was felt in any part of the island at the time, but dead fish were noticed on the 21st and a few days afterwards, to the east of Molokai, and between Molokai and Oahu. The fish gave no evidence of disease, but seemed to have been parboiled. At Honolulu, two hundred miles from the eruption, the atmosphere was exceedingly thick and hazy. So much was this the case that it caused considerable excitement, before the news of the eruption arrived.
>
> Rev. Lorenzo Lyons, of Waimea, states that on Sunday afternoon, January 23, smoke was seen gathering on Mauna Loa. In the evening lava spouted up violently near the top of the mountain on the north side, and apparently flowed both towards Hilo and towards the west side of the island. This continued but a few minutes, when at a point considerably farther below the top, and farther west, another jet spouted up. Accounts from Hilo say, that on the night of the 23d, it was so light there that fine print could be read without difficulty. After the 23d the light was much less. At Lahaina, more than one hundred miles distant, the whole heavens in the direction of the eruption were lighted up.
>
> Our party started from Honolulu, February 1st, and reached Kealakeakua on the 3d. Here we learned that the stream from the eruption had reached the sea on the 31st of January, at Wainanalii, about forty [sixty] miles from the place of eruption. This makes the average progress of the stream above five [seven] miles per day. After procuring guides, natives, pack-oxen and mules, we started for the source of the flow on the 5th. About noon we had a view of the source, distant from us, probably, twenty-five miles in an air-line. The crater was about one hundred and fifty feet high, and two hundred feet in diameter (as we afterwards estimated). From within this crater liquid lava was spouting up to the height of three or four hundred feet above the top. In shape and movement it resembled a mighty fountain or jet of water, though more inconstant. At one moment it was uncommonly high and quite narrow at the top, at the next not so high but very broad. At night, and from a good position near, the view of the jet, according to Mr. Faudrey (the only man who reached the crater while the jet was spouting), was grand beyond all description.

---

[62] Amer. Journ., xxvii, 411. Letter of Feb. 3, 1859.

[63] Ibid, xxxv, 296. Letter of Nov. 13, 1862.

[64] Ibid, xxxvii, 415. Letter of Oct. 6, 1863.

Owing to an accident which befell one of our party, and the failure of water where it was supposed to be abundant, we were delayed two days and induced to divide our party into two divisions. One part returned to visit the flow at a point some twenty miles below, by another and easier route. The party who went on, consisting of twelve white persons and thirty kanakas, reached the crater Wednesday evening February 9th, and encamped about two miles from it. Here all fears about water were at an end, for we found snow in abundance within half a mile of our camping ground. In the evening the view was magnificent. The jet had ceased to play; but two craters, about eighty rods apart, were sending up gas and steam, with appearances of flame. This apparent flame, however, we afterwards ascertained, was only fine particles heated to redness. The noise attending this action was like that of an ascending rocket, very much increased of course, but quite irregular. About half a mile below the lower of the two craters, the stream first made its appearance. For five or six miles its course was well defined, and there were no side streams. From this point the main stream divided more or less, and on the plain between the three mountains Hualalai, Kea and Loa, the branches extended over a breadth of three or four miles. Some of these streams were very broad and sluggish and partially cooled, some were narrow and running, as it seemed, at the rate of two or three miles per hour, burning the jungle and trees before them, and vying with each other in their work of destruction.

For the first few miles the stream appeared to be a succession of cataracts and rapids. As it approached the plain between the two mountains, it gradually changed into a network of streams, or a lake of fire, embracing numerous islands and sending out streams on all sides. The color of the stream on its first appearance was a light red approaching to white: on the plain a deep blood-red. From the plain towards Wainanalii the stream was narrow, varying from half a mile to a mile in width, and showing only a dull reddish light...... The next morning we were able to make some explorations about the craters. On the windward side we could ascend them and look in, though the heat was so great that we could look for a moment only, before turning our faces away. The sulphurous gases also were so strong that we were obliged to close our mouths and noses as we approached to look in. The craters were both very irregular in shape not only on the outside but on the inside. No liquid lava was seen in either at the time. In each there were two or three separate holes where gases and steam were issuing. The sides of these holes, and indeed the entire bottom of the craters, were at a white heat. The lava-stream appeared to be running underneath these craters, and the holes within seemed to be merely vents for the escape of gases. The craters were formed of fragments of light scoriæ and lava combined. The lower of the two (the one from which the jet was thrown up for fifteen days) was now open on the lower side. This was not the case while the jet was thrown up, according to Mr. Faudrey...... The upper crater was closed on all sides.

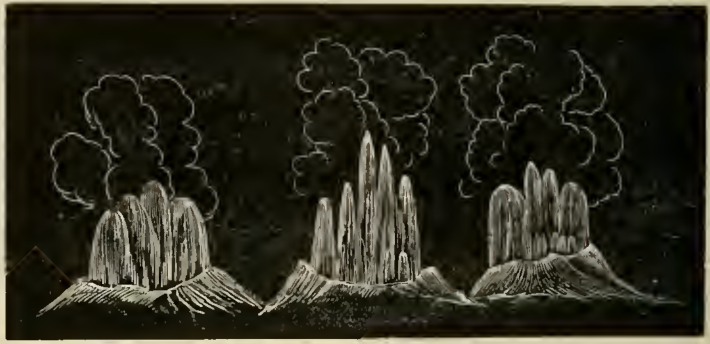


FIG. 51. VIEWS OF LAVA FOUNTAIN SEEN FEBRUARY 6 AND 7, 1859.

Above these two craters we visited a third not then in action, but still hot. This was smaller and open on the lower side, and broken down somewhat on the upper side. This was formed not so much of scoriæ as of old lava. Above this we could see others of the same kind...... The next morning we visited the point where the stream first made its appearance. Here we found the lava rushing out of its subterranean passage, and dashing over cataracts and along rapids at such a rate that the eye could scarcely follow it. The lava was at a white heat, and apparently as liquid as water. Only a few feet from where the stream issued, small masses of lava were thrown up from ten to fifty feet

> into the air which cooled in falling...... About three hours afterward we returned to the same place, and found that the action had greatly increased. Gases were escaping at two other points [Fig. 52, B and C] a few rods below the point first seen. Pieces of lava were thrown as high as one hundred and fifty feet, and at the lowest of the three points [Fig. 52, A] there was a fountain twenty-five feet high. The bits of lava thrown up cooled as they fell, and had already formed craters ten feet high around two of the points where gases were escaping......

Prof. Haskell followed the stream down some distance, and was struck with the great rapidity of its motion. The slope was considerable, and cascades and cataracts followed each other. The width of the stream here was from twenty to one hundred feet. His description of the formation of aa (which he does not distinguish from clinkers) is as follows:

> The clinkers are always [generally] formed by deep streams, and generally by wide ones, which flow sluggishly, become dammed up in front by the cooling of the lava, and in some instances cooled over the top, forming, as it were a pond or lake. As the stream augments beneath, the barriers in front and the crust on the surface are broken up, and the pieces are rolled forward and coated over with melted lava which cools and adheres to them more or less. Then from the force of the melted lava behind and underneath, the stream rolls over and over itself. In this way a bank of clinkers ten to forty feet high, resembling the embankment of a railroad, is formed. Often at the end of the stream no liquid lava can be seen, and the only evidence of motion is the rolling of the jagged rocks of all sizes, down the front of the embankment.[65]

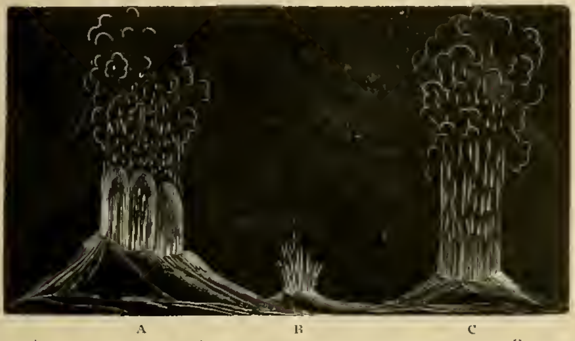


FIG. 52. LAVA FOUNTAIN OF FEBRUARY 10, 1859.

In another letter Prof. Haskell writes under date of June 22, 1859:

> I have just returned from a second visit to the scene of the lava-flood on Mauna Loa. There is one fact which I observed that I desire to communicate to you. The real source of the flow is about four miles above the two craters which in February seemed to be the source. From this point down to the two craters, a crack in the mountain can be traced nearly all the way. At first it is no more than two inches in width, but gradually increases to two feet. At the present time heat can be perceived in the crack within a few feet of the higest point. But little lava has issued from this crack above the two craters. During the first quarter of a mile lava has oozed out in different places a few rods apart, to the amount of three or four cubic feet. Below this point there is a stream, now cold of course, a few rods in width. In this flow, therefore, there is no doubt that there is a continuous crack in the side of the mountain for four miles. How much farther this crack extends down the mountain cannot be ascertained, now at least, for the craters are still sending forth immense volumes of sulphurous vapors, and the stream of lava is still flowing below them. This stream, however, is much smaller than it was in February, and is entirely subterranean for the first twenty-five or thirty miles, except that there are a few holes where the running lava can be seen. In some instances this stream is as much as forty feet below the surface.
>
> During this trip I went to the top of Mauna Loa. There is no perceptible action in the crater of Mokuaweoweo. The source of the present flow is probably 11,000 feet above the level of the sea.[66]

---

[65] American Journal, xxviii, 66. [66] Ibid, 284.

I will here insert some of the valuable observations of the careful observer of Hawaiian volcanic action, Mr. Wm. Lowthian Green, given in his Vestiges of a Molten Globe. Of the entry of the stream of lava into the sea at Wainanalii, he says:

> It ran over a low shelf about ten feet high, and extended perhaps 500 or 600 feet wide, and fell into the sea where it was about twenty or thirty feet deep. It came from under the crust in great red-hot flattened spheroidal masses, having something the appearance of masses of moderately thick porridge as it is poured from a saucepan. The spheroidal masses, however, being perhaps ten feet to fifteen feet wide, and four to six feet deep. There was no steam, vapor or gas whatever to be seen coming from this lava till it went under water. Indeed the first contact with the red-hot spheroids did not seem to produce a particle of steam, and it was only when each had gone under water and become partially cooled off, that a puff of steam rose above the surface. The molten lava from this 1859 opening 10,000 feet up on Mauna Loa, for several months quietly *ran over* without any visible steam, noise, earthquakes or commotion of any kind.—(Part II, p. 163.)

Again the explosions so common during the flow of lava from the Hawaiian mountains, he correctly explains as follows:

> In 1859, on the evening of the day just referred to, I started with two guides—goat hunters—to visit the orifice of eruption of the lava we had been observing spreading itself over the plateau between the mountains Loa, Kea and Hualalai. We camped about nine o'clock on the flat between these mountains close to a portion of the lava stream which was spreading itself plentifully over the ground, and all night long we heard loud explosions like the reports of heavy cannon. At the time I did not know the cause of them, but on my return I happened to be close to an explosion under a stream of lava, and which was evidently caused by the white-hot molten lava flowing over a hollow in one of the innumerable old lava streams. It is to be observed that in this part of the mountain there is no water. All the apertures of some underground cavern having been sealed up by the molten lava, it is only a question of time how soon an explosion of confined, highly heated air will occur. The molten lava may sometimes run into these caverns and so assist both the heat and compression (l.c., p. 270).

We have not yet exhausted all that Mr. Green can tell us of this flow, which will help our understanding of all others on this island. He continues (p. 274):

> When we pitched our tent on our way to the 1859 crater, in the neighborhood of the loud explosions already referred to, it being then quite dark, we had a fine view of the pillar of fire at the crater on the side of the mountain fifteen miles above us, and which all day had shown as a pillar of cloud or smoke. This at night became illuminated by the glare of the white-hot lake of lava in the crater. We were on our way to it early next morning, and although we did not rest more than an hour during the day, it was dark again when we arrived alongside the great pillar of fire which rose ten thousand feet at least above our heads. We had for some time been crunching our way over the glass-foam which had evidently proceeded from the great lava fountain which had now ceased spouting; and close to the crater a steep escarpment appeared, up which we climbed, and when nearly abreast of the centre of the crater, and a little below the level of the edge, we pitched our tent and laid our blankets in a hole in a lava-bespattered crag which was partially filled with the same glass-foam. This lava-fountain seemed—as I found in the case of the 1868 outbreak afterwards—to have broken out at the intersection of two fissures, one leading to the top of the mountain and the other more or less at right angles to it. After our evening meal, I climbed over the rough lava a short distance to get a good view of the scene. It was unique. From the whole interior of the crater rose the great illuminated column of smoke, apparently about five hundred feet wide. The sight was grand and

fascinating. Perhaps the circumstance which impressed me most was the dead silence which reigned. The noisy explosions of the night before had been left far behind. There was no wind, and the now illuminated smoke rose as it had done the day before in a well-defined perpendicular column, but spreading out on all sides at a great height in the atmosphere. I gazed at it long and steadily. I had toiled all day to get to this spot and to learn something, perchance, about volcanic action, but here at the crater, the only idea which I seemed capable of realizing, was my own utter insignificance amongst this waste of fire, smoke and lava, and as I turned from the view a moment to look back at the little white tent, tinged with a lurid red, perched amongst a chaos of black slags, I felt as an astronomer might, who, looking through his telescope at the surface of the moon should suddenly discover a habitation; the difference being that here I seemed to be in the moon, or at least in a spot which was equally unearthly and unsuited for human existence. The exertion of the last two days made my bed of pumice welcome, and after retiring I slept till daylight, not a single sound having disturbed us. On looking out in the morning, the great, steadily rising pillar of cloud beside us was reassuring. The colour of the smoke, by daylight, seemed to be about the same as that of a steamer burning Welsh or semibituminous coal after she first fires up. It rose gently, curling in great wreaths and folds, just as it might from the funnel of a huge steamer. I made an attempt to climb the edge of the crater and look in, but after scrambling for some time out of one sulphury crack into another, a thick fog crept up the mountain side and enveloped me, so that I could see nothing in any direction, and was glad, when on retreating, I found myself within hail of my guides, although I could neither see them nor the tent. In the course of an hour or two the fog cleared up, and we started down the mountain, our provisions and water being only sufficient for half a day longer. In descending I kept as near as possible to the lava stream which was running from the lower part of the crater, in the usual covered passage formed by its own cooled crust. At the lower side of the crater, just where the slope became moderate, we observed some vitrified breakers. The molten glass-foam had run over the lip of the crater in great waves and now stood on the gentle slope below, like petrified combers on the sea shore. The likeness was the more remarkable because the break of the waves was up the slope, and the falling crests were in the opposite direction, mechanically speaking, to those of the ocean waves......In some places the wave seemed to have bent, fallen and doubled upon itself, and the vesicular glass had solidified in great folds of a delicate green shade, looking like the folds of satin as they are sometimes displayed in a shop window.[67] The material of the waves seemed to be identical in composition and colour, with the usual Hawaiian pumice or glass-foam [limu], and the semi-transparent glaze covered the whole outer surface.

We got belated, and were compelled to go supperless to rest on the ropy pahoehoe, which, with nothing but a blanket to interpose, was not so comfortable to lie upon as the pumice at the crater. It was, however better than aa, and rising early next morning, we arrived at the camping ground just in time to hail the native, who was leaving with our horses, and who had been instructed to wait for us: the rest of the party having left for Kailua the day before. We could hardly have blamed him for leaving us to get to the coast as best we could. He had concluded that we were *make* (dead). Few Hawaiians could have been found to remain a night alone amidst the fires and thunders of their offended goddess Pele.

The immense columns of smoke which so constantly rise from the orifices of eruption on Hawaii, may often be largely composed of the vapor of water. When the lava breaks away, great red-hot chasms must often be left, and percolating surface water may well find its way into them and escape at the only opening, that is where the lava escapes. At the time of my visit to the 1859 crater, the top of the mountain was covered with snow, which would be one source of percolating water.... One important ingredient in most Hawaiian volcanic smoke so-called, is the excessively light, glassy threads, films and vesicles, which the heated air first forms, and then raises to a great height in the atmosphere...... The next time I visited this river of molten stone was some months afterwards at the sea-shore at Wainanalii, where it had never ceased running into the sea. It finally ceased in July.

---

[67] This identical formation appeared also in the eruption of 1880–81 according to a painting by Mr. Furneaux now before me. It is shown, although not so clearly as I could wish, in the right foreground.

In 1864, Mr. Horace Mann and the author approached Kilauea from the southwest on the Kau trail. For ten miles we had seen the cloud of smoke over the crater, and for more than half that distance we had traversed beds of pahoehoe, and large tracts of sand deep and difficult for our horses. No aa and but little scoriæ were visible from the path. The eruption of 1789, is said to have thrown out the sand, but the winds have entirely changed its original location. It is dark, fine and uniform, and it now lies covering the pahoehoe in places to the depth of several yards. Soon after one o'clock we came upon the brink of the crater near Uwekahuna, the highest part of **1864** the bounding wall, and from here in the afternoon is a favorable view of Kilauea, perhaps the best. From below us steam and sulphurous vapors rose in a sluggish column, but we saw no fire and heard no noises. The great sunken plain before us, covering four or five square miles, looked bright in the clear sunlight, and even the walls on which we stood were of a light gray color. The whole circuit of the walls on the west and north sides is much cracked and interrupted. We rode along

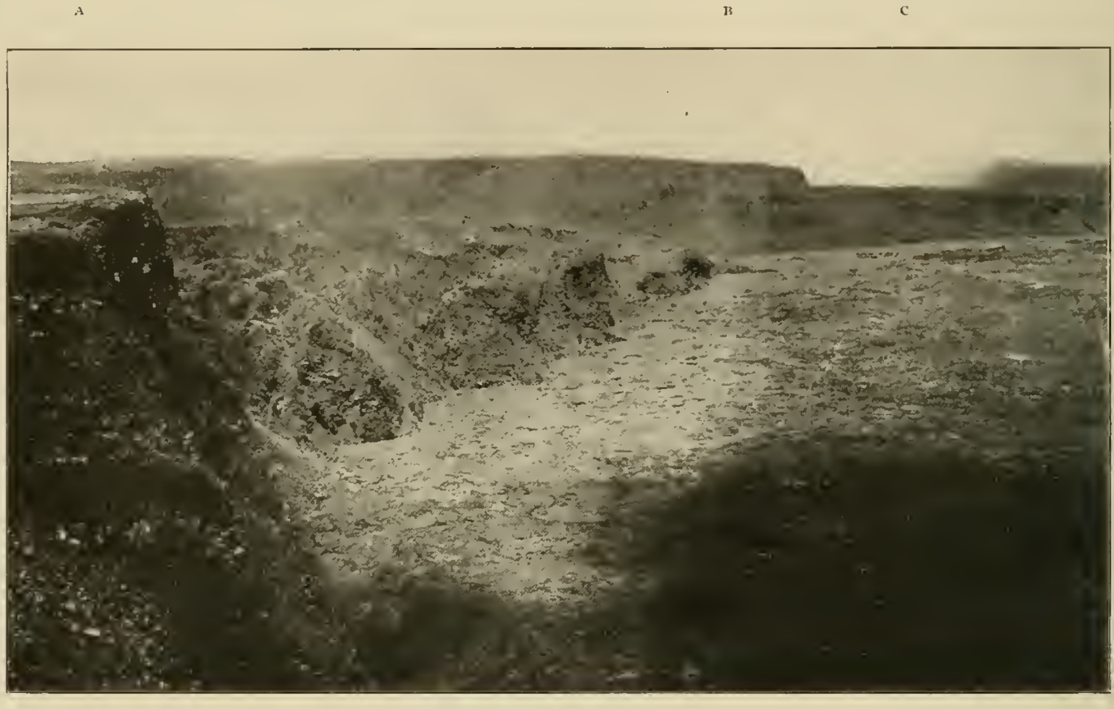


FIG. 53. NORTH END OF KILAUEA FROM WEST BANK. A, SITE OF HOTEL. B, BOTTOM OF DESCENT. C, KILAUEA IKI WITH A SHOWER OF RAIN.

over several cracks, one of which, a little more than a yard wide, had opened about a year since, accompanied by an explosion heard distinctly at a distance of twenty miles. Some of the cracks were parallel with the edge of the abyss, others were at right angles to these, and in one place the small cracks were so numerous as to resemble a geometric spider's web.

Passing over the high cliffs on the northwest, the road leads down by a steep descent of fifty feet to a plain a mile long, and three-quarters of a mile wide, gravelly, and covered sparsely with a growth of dwarf ohia and ohelos, and dotted with small oval or circular fumaroles, from which steam was issuing silently and abundantly. The steam had no odor, and ferns and other plants grew luxuriantly over the openings. Around these steam holes the muddy and tenacious red soil retained pools of excellent water condensed from the steam. There was no trace of sulphur or acid in it that could be detected by the taste or by the more delicate test papers. The rock through which these steam holes passed was completely decomposed from a hard gray clinkstone to a red loamy earth, soft and worn smooth by the ascending vapors. It was quite evident that these fumaroles were not originally formed by the vapor, but were simply cracks through which the steam escaped, and the circular shape resulted from the falling in of the surface gravel and soil. The steam was quite hot, and we saw the remains of several cattle who had gone too near in search of water.

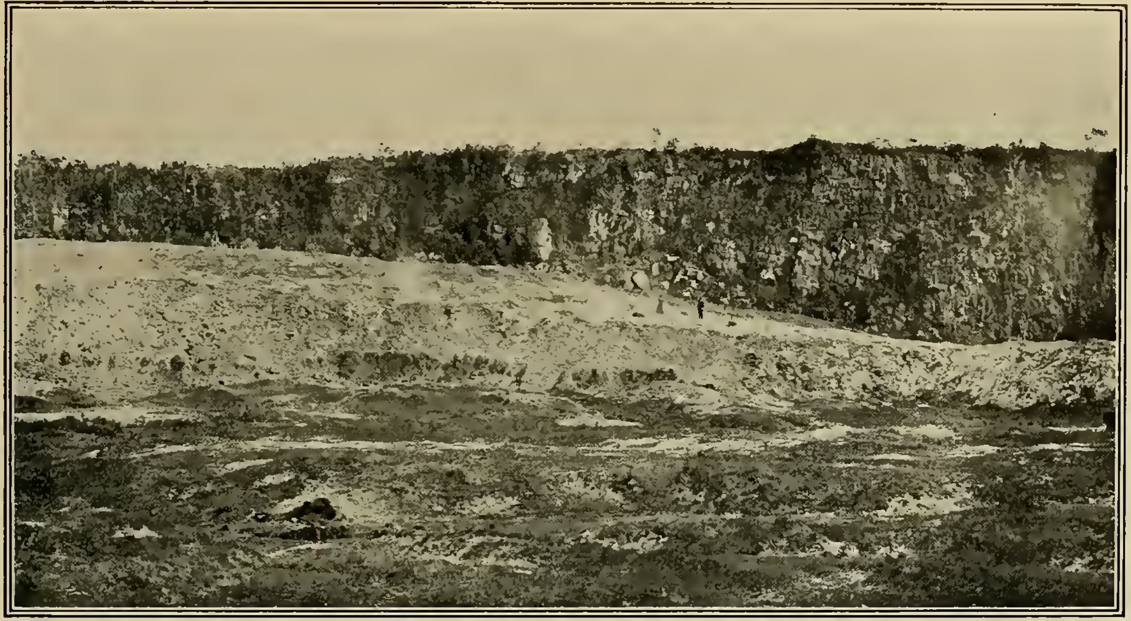


FIG. 54. THE NORTHERN SULPHUR BANK IN 1889.

On the northern edge of this plain are extensive sulphur beds, that is to say, they cover a large space although containing but little sulphur, under a perpendicular ledge of clinkstone nearly a hundred feet high. They are simply great piles of decomposed lava through which steam and sulphurous vapors constantly escape through a thousand apertures, depositing beneath the cool crust the most beautiful, almost acicular crystals of sulphur.[68] The soil formed by the decomposition of the rock by sulphurous vapors is quite unlike that resulting from the action of steam alone; it is light gray or yellow, and does not form a plastic mud as readily as the latter, which is red and smooth to the touch. In some places the sulphates of oxides of copper, iron, sulphates of soda, lime and alumina were forming within minute fissures, and the silica thus set free was gradually consolidating the earth into a firm crust whenever the supply of steam ceased, and we could often raise large slabs of this curious conglomerate. Metamorphism was progressing rapidly under the combined influence of heat and moisture. Twigs and leaves were fast passing into the condition of fossils in this hardening earth. All the sulphur found here is deposited from the vapor, seems to be tolerably pure and is of a light yellow color indicating the absence of

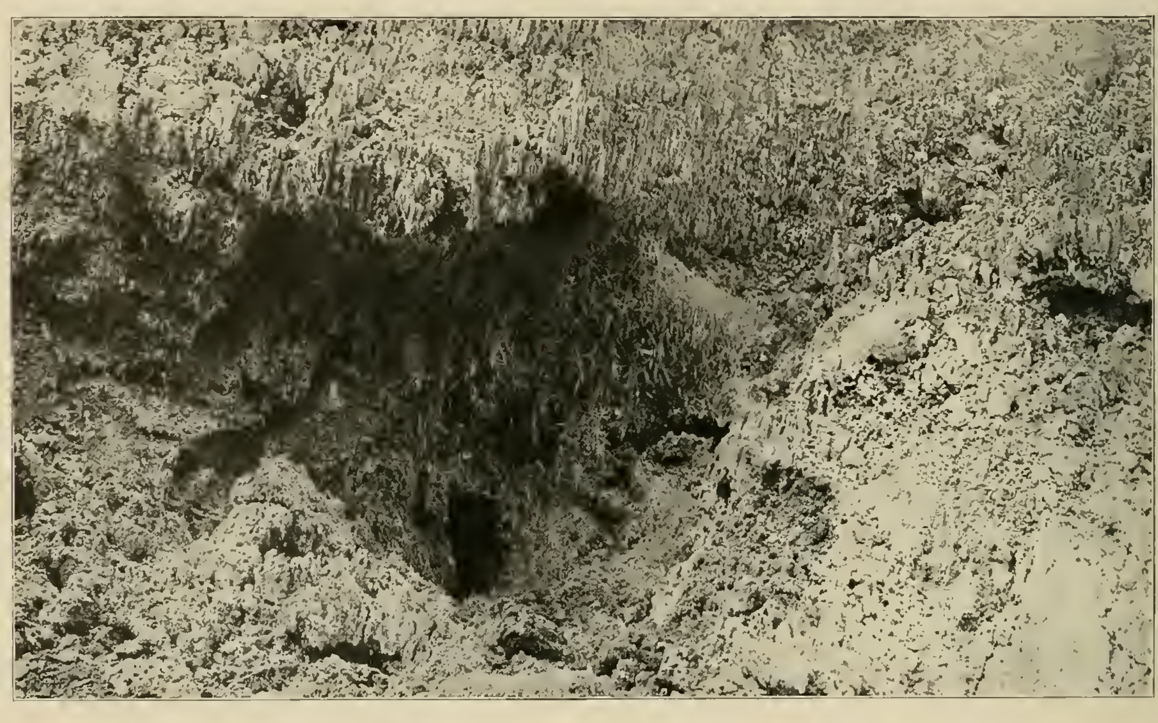


FIG. 55. FUMAROLE IN SIDE WALL WITH SULPHUR CRYSTALS, 1889.

---

[68] Although the two illustrations of the sulphur bank were taken by the author twenty-five years after this visit, there is little change in the first and none in the second so far as the deposit of crystals is concerned. In 1864 the sulphur proved too strong for the wet plate process then used.

selenium. At first it seemed that this plain had sunk, but farther examination convinced me that this was once the floor of the ancient crater,—a black ledge.

As soon as our men came up with the blankets, we engaged guides and went down into the crater. The descent was steep and winding, and we passed over several terraces which were the result of a sinking or falling in as their strata were inclined and much broken, and came under the grand wall of compact lava figured in the Narrative of the United States Exploring Expedition.[69] A descent of some four hundred feet brought us to the bottom, and we stepped from a gravelly, shelving bank on to a black lava which had broken out last year under the north bank, and overflowed this end of the crater. Where it touched the gravel bank it had glued to its under surface the small fragments of stone, but had not altered their appearance, and all along the edge it was cracked, and laid up on the bank as if, on cooling, the lava had fallen about a foot. The surface was covered with a thin, scaly, vitreous crust, which crumbled beneath the tread, sounding like snow on a cold morning, and thus a very distinct path was made to the Halemauman, the enduring house of Pele. The lava beneath this crust, however, was so hard as to strike out abundant sparks as the steel

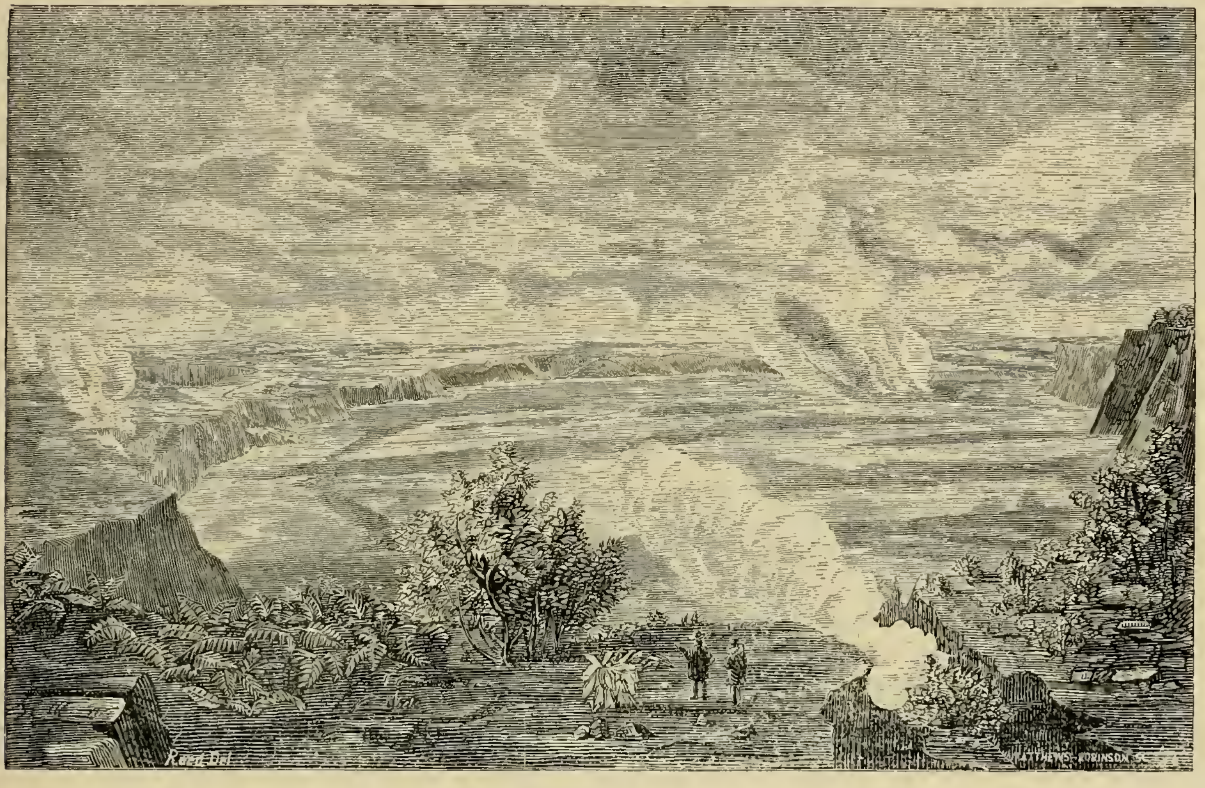

MATTHEWS-ROBINSON SC.

FIG. 56. KILAUEA IN 1864. PERRY.

---

[69] Named "Waldron's Ledge" for the purser of the expedition. Vol. iv, p. 171.

nails in my shoes scraped upon it. When hard it was often iridescent, like some anthracite coal, and so closely resembling this mineral that the difference would hardly be detected on a cursory examination. The fresh lava closely resembled that from Mauna Loa in the flow of 1859. Three-quarters of a mile over this uneven lava, and we came to a wall of fragments of every size of compact light-colored lava, very solid and heavy and containing many small grains of olivine quite different in appearance as well as size from that in the lava of 1840; and this wall, which is roughly concentric with the outer wall of Kilauea, is said by the natives to rise and fall and sometimes disappear. The stones so closely matched the outer walls, that I had no doubt that they had fallen from these walls, loosened by some of the many slight earthquakes and floated out to its present position. An unpractised eye could see no marks of fire on the rough granite-like masses. All over the floor caves, cracks and ridges make the surface very uneven, and after walking two miles we came to several large cracks of great depth, but not more than a yard wide, and then a wall enclosing an amphitheatre down which we climbed on the loose slabs of lava.

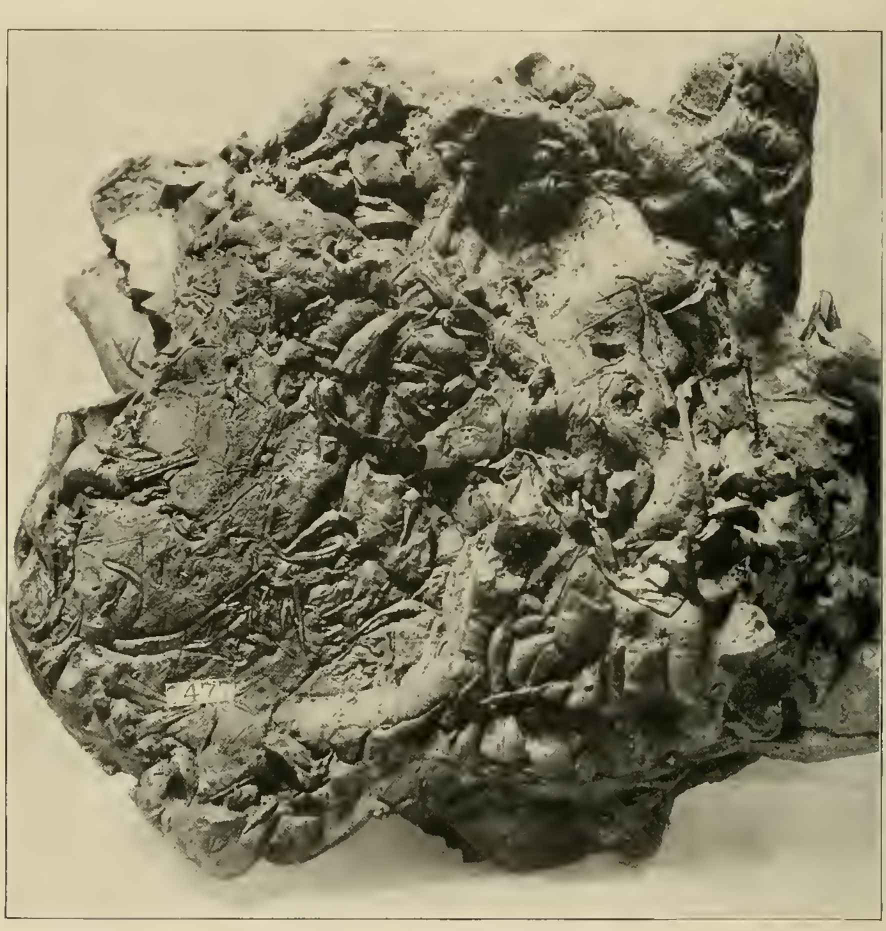


FIG. 57. PORTION OF THE FLOOR COVERED WITH SPATTER.

The whole bottom of the crater is above what Prof. Dana describes as the Black Ledge, and although no fire is visible over the northern and eastern portions, steam constantly rises from many cracks, and the caves are often uncomfortably warm.

When we were near Halemaumau, we came to a cone formed of spattered lava and cemented scoriæ, some twenty-five feet high, with a bright light at its apex. This was the first fire we had seen, but we passed by, eager to reach the great lake. This we reached after ascending a gradual incline. It was eight hundred feet in diameter, and the lava was fifty feet below the cliff on which we stood, covered with a dark crust which was broken around the edges, and there the blood-red lava was visible, surging against its walls with a dull, sullen sound. The smoke was blown away by the wind so that we were able to stand on the very verge of the pit; but the heat was so great that we were compelled to hold our hands before our faces.

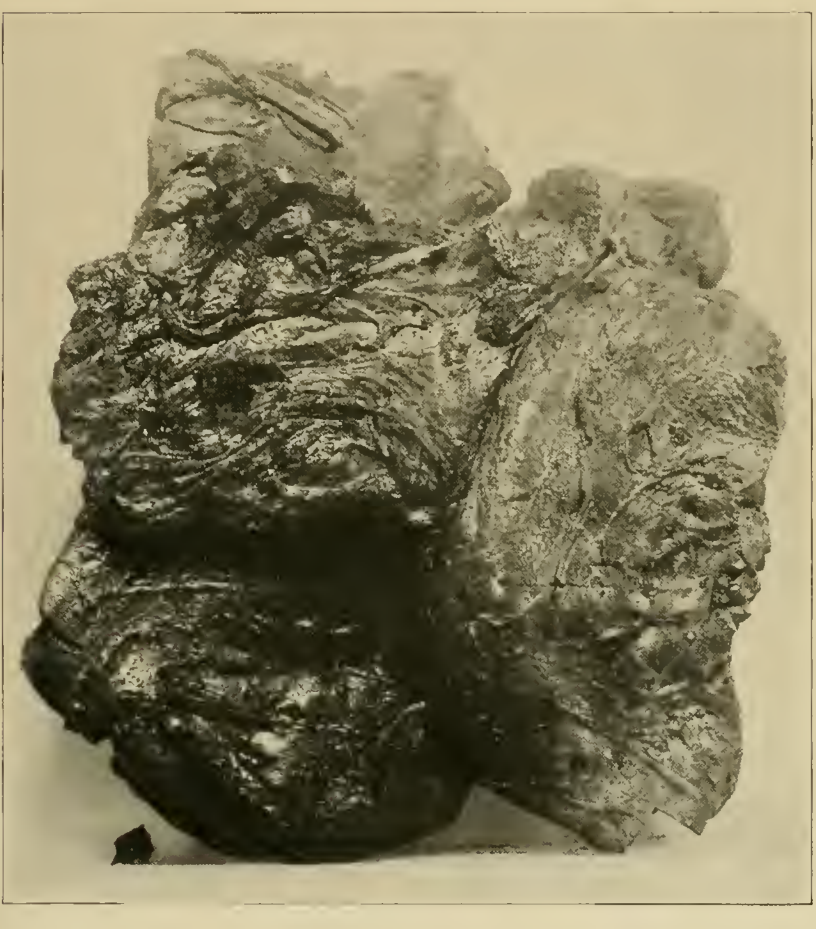


FIG. 58. BOTTOM OF THE FRAGMENT (FIG. 57), SHOWING THREE LARGE DROPS.

The wall on which we stood, and where we intended to sleep, was thickly covered on the side towards the pit, with waving, woolly Pele's hair, which we saw forming continually. The drops of lava thrown up drew after them the glass thread, or sometimes two drops spin out a thread a yard long between them, and the hair thus formed either clings to the rough sides or is blown over the edge, where it catches on any projecting point. The drops are always black, or a very dark green on the surface, but light green within, porous and quite brittle, and the thread is transparent, and when first formed, of a yellow or greenish color. Occasionally a crack would open across the lake, and violent ebullition commence at various points along its surface. There were two small islands in the lake which the lava seemed seeking to destroy. The current would often set in toward the banks, and it appeared as if the whole lake was about to be drawn in as cake after cake broke off from the surface and disappeared. But it would soon cease, and then run toward another point of the wall, and I could not see that it was oftener on one side than another. As a crack opened, the red lava rose above the crack, running on the surface, and as the crack grew wider, cooling rapidly, and being drawn out much like molasses candy. While white-hot, the lava was liquid as water, but it rapidly assumed the viscid condition, and then the solid. I threw a stick of dry wood on the surface the instant it became fixed after a violent bubbling, and it was ten minutes before any smoke was made, and it was only when a crack opened under it that it was consumed. The motion was always from the centre, except when the lava was thrown back in spray from the caverns which extended under much of the wall.

We laid down in our blankets on the eastern edge where the wall was highest, and the wind drove away the smoke, and soon fell asleep. About nine o'clock I got up and moved to the very edge of the pit to view the molten mass to better advantage, and warm myself, as the wind from Mauna Loa towering ten thousand feet above us was quite cold. The moon was up and almost full, but her orb was pale beside the fires of Pele. Finding the place quite comfortable, I lay down and went to sleep. At twelve I awoke with a start, and found myself in the midst of a shower of fiery drops, some of which were burning my blankets. I shook myself and jumped back, looking at my watch to note the time, for I thought a great eruption at hand, and then stood gazing at the strange scene for some time before I thought of calling my companions. The whole surface had risen several feet and was boiling violently and dashing against the sides, throwing the red-hot spray high over the banks and causing the providential rain of fire which awoke me to see this grand display. There was no noise except the dash and the sullen roar. When I could think of anything else, I called the others, who were asleep several rods from the edge, but only succeeded in awakening the guides, and just then a drop came plump on to a greasy paper in which we had brought our supper, and it blazed up so suddenly that one of the kanakas thought that a new jet was opening at our feet, and ran off to some distance. Failing to arouse my companions by calling, I threw a handful of small stones at them but without effect, and I had to climb down and shake them roughly. When they had got to the edge the action had greatly diminished, and in a few minutes more the dark crust again covered the central portion, and we all went to sleep.

I was glad to see such distinct flames, as it had been denied that they exist in Kilauea. They burst from the surface, and were in tongues or wide sheets a foot long and of a bluish-green color, quite distinct from the lava even when white-hot; they

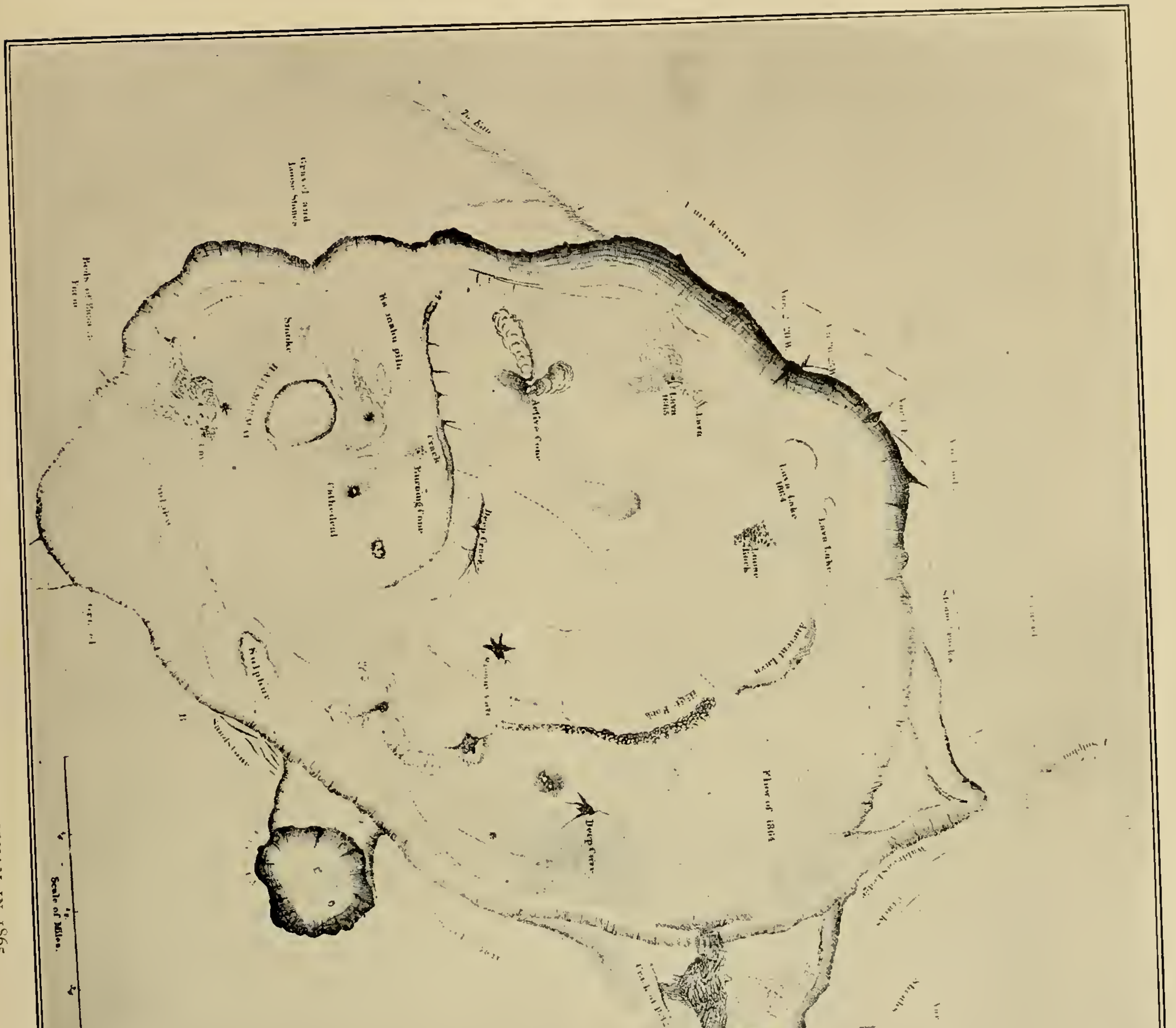

Gravel and Loose Stones
Smoke
HALEMAUMAU
Active Cone
Lava 1865
Lava
Lava Lake 1864
Lava Lake
Crack
Burning Cone
Cathedral
Deep Crack
Sulphur
Ledge Rock
Flow of 1864
Deep Cave
Scale of Miles.

FIG. 59. SURVEY OF KILAUEA BY WM. T. BRIGHAM IN 1865.

played over the whole surface at intervals, and I thought they were more frequent after one of the periodical risings of the surface in the pit.

In the morning we found it very misty, and the mist soon turned to rain, but we went to the cone we had seen the evening before, and climbing its sides looked into its red-hot mouth. It was nearly full of melted lava, but although we tossed in scoriæ we could not excite it. Another cone with several pinnacles called the "cathedral" we did not visit, as no fire was visible, although smoke poured from it copiously. The rain caused steam to rise from the cracks over the whole surface of the crater, and we got quite wet, and our views were wholly cut off. At half-past seven we were in the saddle on the way to Hilo, which was only twenty-nine miles distant, but the road was so rocky in some places and so muddy in others that we were obliged to walk our horses all the way, and it was twelve hours before we dismounted at the house of the excellent missionary who has done more than all others to record the volcanic phenomena which have taken place on Hawaii during his long and useful pastorate.

August 2, 1865, I again visited Kilauea to make arrangements for a survey. The appearance was much the same as last year, although the bottom had evidently risen, and several new cracks had opened, while others had closed. The banks of Halemaumau had changed considerably; the platform on which I had slept before was gone, and the diameter was now at least a thousand feet. The islands had disappeared, and the lava was not more than thirty feet below the top of the bank. We went down in the crater in the evening, and fell asleep with the usual resolve to wake up now and then to enjoy the fireworks; but we were so weary with the tiresome ride from Hilo, that we slept till after midnight, when a puff of sulphurous vapor from a crack under our heads, waked us up choking, and we beat a hasty retreat. In a few minutes, however, the gas ceased to blow, and after enjoying the changing fire of the pool for half an hour, we slept until five in the morning, when our guide advised us to return, as we were to breakfast on the upper bank some three miles distant. We went round by a new pool which had opened during the winter on the northern side near the bank. It was small, hardly two hundred feet long and fifty wide, but the melted lava was not more than a foot below the bank, so that we could work it with our sticks. It was blood-colored and very viscid, and exhibited the same motions as the larger pool,—the currents to the sides, and the cracking and bubbling, but on a much smaller scale. Fire was visible at night at various points between this and Halemaumau.

The next night I slept on the upper bank, in the grass house, while several of our party spent the night in the crater. They could not approach the place where we had slept the night before, owing to the change of wind, and during the night the whole shelf fell in with a loud noise. This formed a small island which was soon broken and melted by the boiling lava.

August 22, I returned to Kilauea from Hilo, having since my last visit explored the district of Puna and the pit craters on the course of the flow of 1840. I brought with me surveying instruments and photograph apparatus (wet-plate most unsuitable to the vicinity of sulphur fumes), and after spending a day in selecting stations and drilling my kanakas in chaining, commenced the survey from the grass house on the northern bank. Going eastward the ground was covered with bushes and full of steam cracks which made chaining very difficult. Waldron's Ledge looks like a continuation of the wall behind the northern sulphur bank, and on meeting the crater edge it turns eastward toward the large lateral crater Kilauea iki, enclosing this with a circular wall four thousand feet in diameter, and deeper than the main crater at present. Descending the steep precipice we came upon the western edge of the gravelly

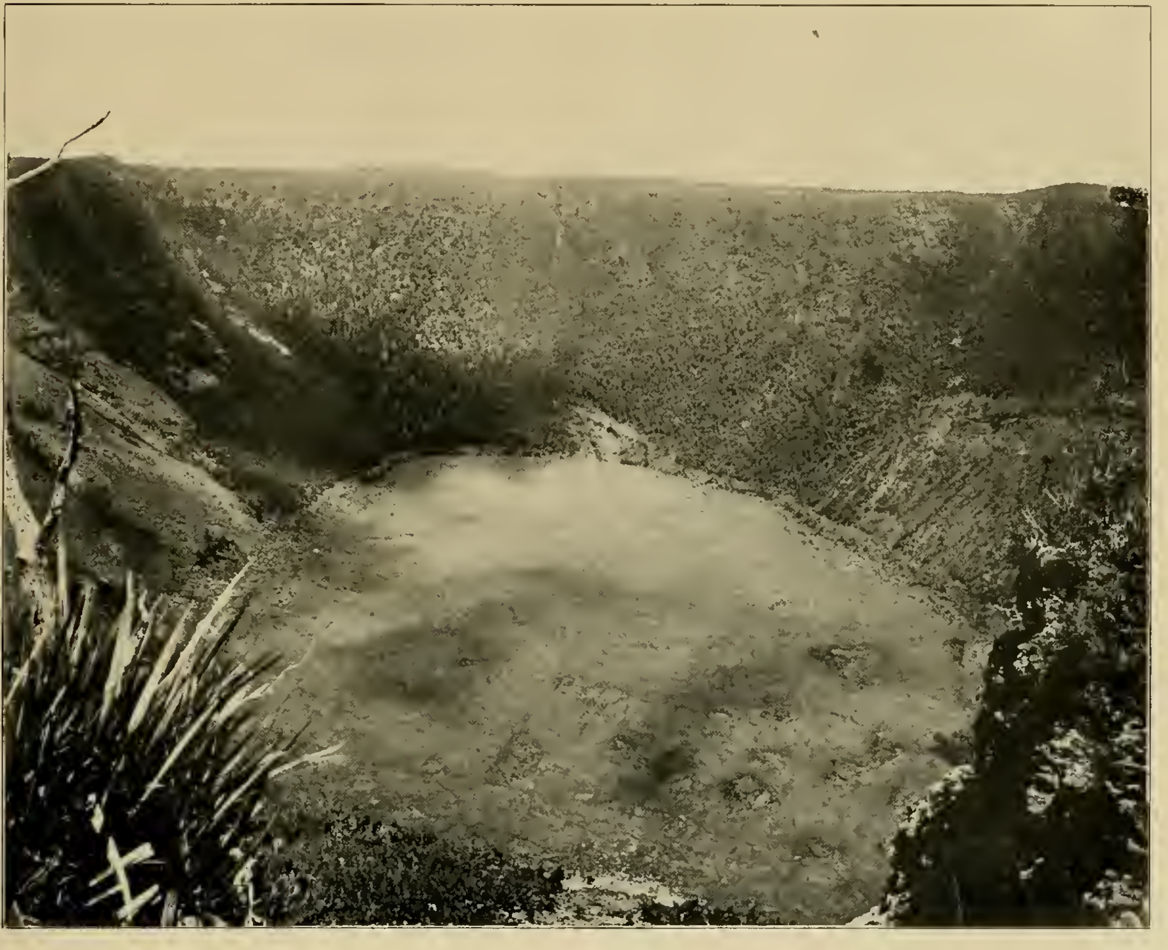


FIG. 60. KILAUEA IKI.

isthmus which separates the two craters. In the midst of this issued the lava stream of 1832 which ran down into both. Its appearance is still fresh, and where it descended into Kilauea over a precipice of 60° and more than two hundred feet high, it has formed a fine lava-fall perfectly continuous, although for a short distance it is nearly perpendicular. It is hollow and of small volume.[70] The ascent from this isthmus is not so steep on the southern side, and above, the soil is gravelly and barren, supporting but few plants. The wall of Kilauea is much cracked and broken on this side and is also much lower. The second lateral crater, Keanakakoi on the southeast is much smaller than Kilauea iki. Its walls are quite perpendicular on the side towards Kilauea, and the depth is greater than that of the main crater. The bottom is gravelly, level, except where a small mound rises near the northern side. Near the edge of Kilauea was a ledge of sandstone much split into vertical parallel plates and evidently formed by the cementation of the volcanic sand common on the banks of this side. There were many curious circular depressions in the hard gravelly soil, about three feet in diameter, and from six to eight inches deep, which I did not at first understand. I soon found that they were over cracks in the subjacent rock, and the sand, which is quite loose a foot below the surface, had settled into these small fissures, causing the depression in the sandstone above, which is almost as flexible as Itacolumite. There were evidences of severe showers over this plain, as the torrent channels were numerous and deep, and always emptied into the crater. The traces of the ancient adz-making, which gave Keanakakoi (the

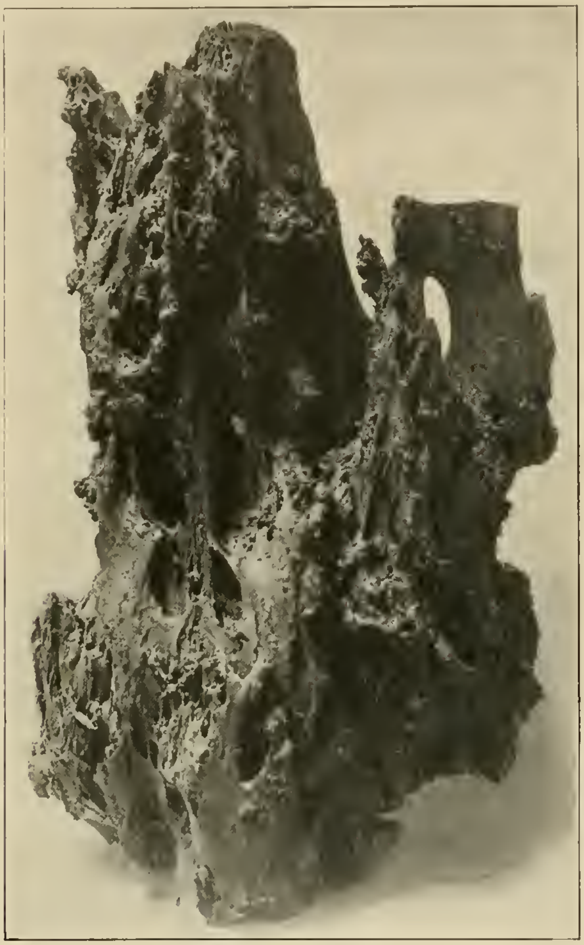


FIG. 61. FRAGMENT OF THE 1862 LAVA-FALL.

---

[70] Only the ruins of this fall are to be seen at present (1909). Specimen hunters and earthquakes have perhaps contributed equally to this result, but forty-four years ago it was the most remarkable lava-fall to be seen on the island. The wall behind it is much cracked and broken, but the remaining fragments have still the fresh appearance noted in the text.

workshop of the adzes) its name, were abundant, but the fragments of the adzes usually abundant in such quarries were not noticed.[71]

At the edge of Keanakakoi, as it was late in the afternoon, my natives built a stone house to shelter the instruments, and we decided to cross Kilauea as the nearest way home. We climbed down a steep gravel bank apparently formed by the action of sulphurous vapors on the rock of the walls, crossed a small sulphur bank from which steam was issuing, and continued our way over the portion of Kilauea which was overflowed the year before. It was very disagreeable walking, as the crust was quite thin and brittle, and we constantly broke through, only a few inches perhaps, but there was a constant feeling of insecurity, for we could not know but that the breaking crust covered a deeper crack in the harder lava beneath. Half way across we found a cone three or four feet high covered with spatters of lava of various colors. Crossing the crater again the next morning in the rain it was difficult to find our way owing to the steam, but we at length reached the bank. It was two o'clock before the mist cleared away enough to permit the use of the theodolite. The large sulphur bank near this end of Kilauea was of a bright green color owing to a large proportion of

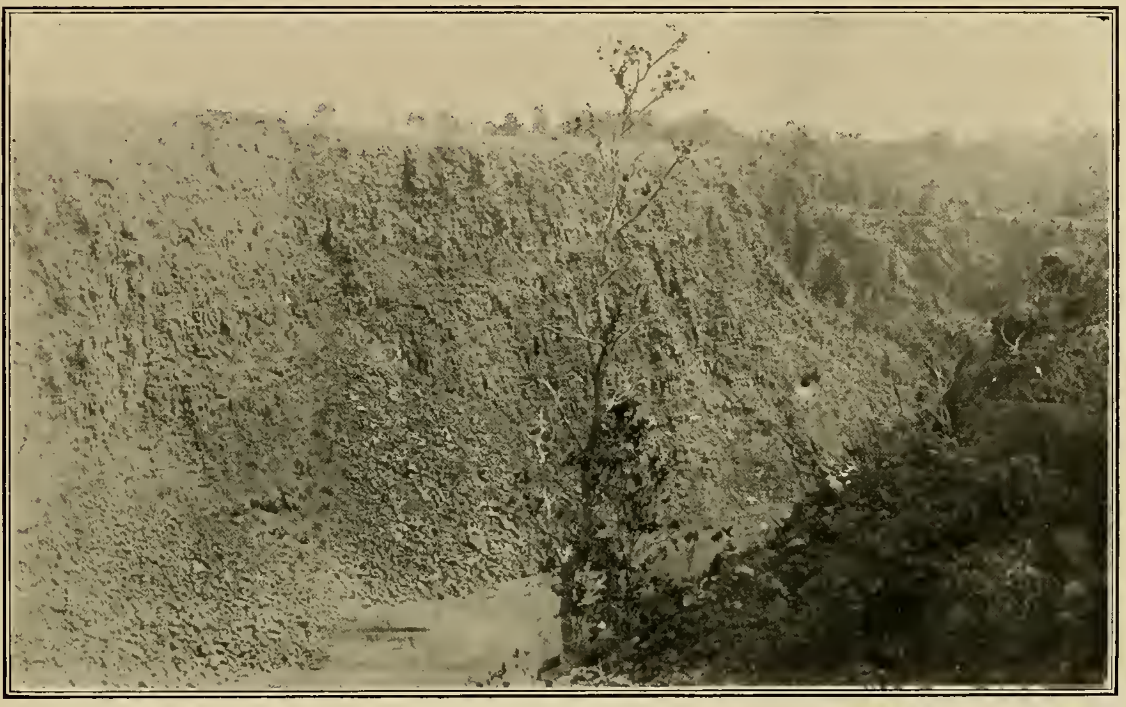


FIG. 62. KEANAKAKOI IN 1889.

---

[71] Every trace of stone-working has been hidden by a subsequent flow of lava which has for more than twenty-five years covered the bottom of this crater.

sulphate of protoxide of iron which seemed to be constantly forming.[72] Much of the sulphur is in large amorphous masses as if melted.

The ground on this side of the crater is smooth, free from stones, and so terraced and sloped that it is difficult to define the boundaries of the great pit. As no rock is visible it is impossible to determine the direction of the disturbing forces, but the present condition of the bank seems to indicate a falling in of the walls in several places, probably over one or more of the subterranean streams of lava that have deluged Puna. The side of the mountain is weaker here than elsewhere, and most of the subterranean eruptions have forced their way through it, forming several lines of cracks and craters extending to the sea. One of Wilkes' signal posts was found rotted off at the base, but otherwise sound.

On the southwest side the smoke from Halemaumau was very suffocating, and I was obliged to pass through it with a wetted handkerchief to my face; so little aqueous vapor was in the smoke that the cloth dried with great rapidity. The ground was covered with Pele's hair, which collected on the leeward side of the ridges and stones, and also extensive beds of the Hawaiian pumice or limu. This limu is identical with that seen on Mauna Loa, and is the froth of the burning lake. As the steel chain was drawn through it the links were completely polished. The deposit was so loose and friable that in one place I sank up to my waist in it. Stones and fragments of scoria were lying about apparently loose, but we found it almost impossible to break them off, so firmly were they cemented to the gravel rock below. The action of the sulphurous vapor seems to speedily dissolve the Pele's hair, and this with the silica in the rock itself makes a solid cement. There is an easy descent into the crater at the southwest end, and beyond this the nearly perpendicular rock wall rises rapidly to the highest point at Uwekahuna.

I reached the highest point on the Kau trail about dark, and sent home the instruments, while I followed slowly along the bank, watching the fires which were gleaming brightly seven hundred feet below. The small new pool close beneath the bank was exceedingly beautiful, as it emitted but little smoke, and constantly cracked and broke up its crust, forming an everchanging network of fire. A line of fire was burning all the way from this to Halemaumau, but the level of the new pool is more than fifty feet below the old.

Saturday it was rainy and impossible to obtain sights with the instruments, so I went into Kilauea to explore the caves. Halemaumau was not in a very lively condition, and passing beyond that, I went into a cave of considerable extent, where the curious silicious tubes had formed on the rock roof, and obtained many of these fragile specimens, some of which were coated with beautiful white crystals. This cave was more than fifty feet below the level of the lava in the main pool, and the walls did not seem very secure. A small lava stream had recently poured into the mouth of the cave, but there were no vapors, nor any uncomfortable heat. Taking advantage of a change of wind, I passed around Halemaumau, and ascended a cone with two peaks formed by lava spatters, but completely closed on the top, as nearly all the others in the crater were, and found steam hissing from many apertures. On breaking off the crust fine crystals of various salts were found thickly coating the inner surface, and in one place we found much potassa nitrate. I went from cave to cave, from cone to cone, collecting many kinds of lava and some salts, and finished by a bath in a steam cave, where the steam issued from the floor at an agreeable temperature, and condensed on the roof falling in rain. The water was quite sweet, and no smell of sulphur was noticeable in the cave. On the roof the little tube stalactites were constantly forming by the solution of the silica in the rock above, and I broke off the twisted, brittle tubes sometimes a foot long. On the floor the drops had made stalagmites of various forms (see Plates XLVIII and XLIX).[73] This steam bath was most delightful after the smoking I had just experienced in a cave where the end was red-hot, and into which my natives did not dare to follow me.

---

[72] A few years after this (1867), a flow from Halemaumau reached this long bank and set it afire; the combustion was slow but complete, and the gravelly residue is covered on the sides with coarse ferns.

Sunday was the first bright day I had had, and the pulu[74] pickers from the region came to my hut after the morning service, and told me the names of the various parts of the crater, and legends of various eruptions.[75] Monday was rainy, but I completed my measurements, and in the evening made a series of observations to determine the declination of the magnetic needle. The electric currents in the lava and the large amount of iron in the rock, made strange work with the compass: I have seen the needle turn suddenly through an arc of forty degrees. The remainder of the week was too stormy to take photographs, and I was reluctantly obliged to send back my instruments and return to Hilo.

---

[73] These stalactitic formations have been fully described and figured in the section on the lava forms. No one can well understand the formation unless able to watch the process as I have repeatedly done at this visit, checking my results at subsequent visits to these and other caves, and I am not surprised that Dana, who never saw them *in situ*, should question the accuracy of my observation. After many years I do not care to alter my original description, which I believe true, and have quoted in full in the section referred to.

[74] Pulu is the silky covering of the opening fronds of several species of tree ferns, and was formerly exported in large quantities to California for bedding, etc. The material proved undesirable in a dry climate, the export ceased, and the present generation knows nothing of this interesting business.

[75] It was here that I got the name Poli o Keawe (bosom of Keawe, or place of torment of Keawe), which I gave to the larger lateral crater on my map of this survey instead of the name given by Ellis, which I now resume. The name of Poli o Keawe was certainly applied to some place in the immediate vicinity of Kilauea, but I have not been able to identify it. It may be added that the natives have generally lost the accuracy of local knowledge possessed by their fathers, and when they do not know the name of any place will not own to their ignorance, but often give any name that occurs to them.

Pit Craters in Puna a Part of the Kilauea System.—A region that has been the chosen path so often for the escape of the Kilauean lava, would naturally excite the strong interest of a geologist, but until within a few years the whole district was an almost impenetrable wilderness. The Rev. Titus Coan was the first who discovered the craters on the line of the eruption of 1840. Dr. Charles Pickering extended his explorations to a greater distance and mapped some of the larger craters, work after adopted as official on the chart of this region published with the Wilkes report.[76] In the early sixties the business of picking and packing pulu had become so important that trails cut by the many natives thus employed, opened the crater country far more than ever before, and at this time I was fortunate enough to go through the fern forests with Father Coan, and although I have been several times through the strange path of Pele, cutting it here and there, I was more impressed with this first visit and will transcribe from my note book what I saw.

Here and there on the way from the coast at Panau we passed lava streams. Ohia trees were growing on these, thin and tall, suggestive of alpine regions; indeed I have seen similar forests on the Swiss mountains, and there was a peculiar grace, which, while pleasing the eye yet conveyed the idea of a struggle for existence amid the storms which sweep the rocky slopes of Mauna Loa. At the height of eighteen hundred feet we entered the fern forest. The fruit of the poha (*Physalis*) and ohelo (*Vaccinium*) was abundant, and sandal-wood was occasionally met with at an elevation of two thousand feet. As we came to the fern region, we turned into a path cut through the jungle, and, as the soil was a soft black mould, it had been paved with the stems of the tree-ferns about six inches in diameter. This "corduroy" road was constructed with great labor by the natives, and we calculated that forty thousand pieces of fern were used to build it. The ferns are cut in lengths of six feet, and many of them sprout and make a green edging to the roadway. Nearly two miles along this tropical and attractive road, and we came to a tract of pahoehoe where was the pulu station to which the roads had been cut. This was the residence of a remarkable Hawaiian who had leased the whole district for the pulu business,—Kaina, the district judge. His house was directly on the line of craters, and only a few rods from steam cracks where his men cooked their food. It was well built, and surrounded with a substantial stone wall. The interior was furnished with bedsteads, rocking-chairs, and other conveniences; and our supper table was supplied with fresh wheaten bread, milk, butter, eggs and delicious ohelo berries.

West of the house was a large open field where the silky, golden fibre of the pulu is dried before packing, and beyond in the woods, I found curious tubes of lava

---

[76] See outline of this chart on page 51. The names given by Wilkes are not those at present used and have been omitted.

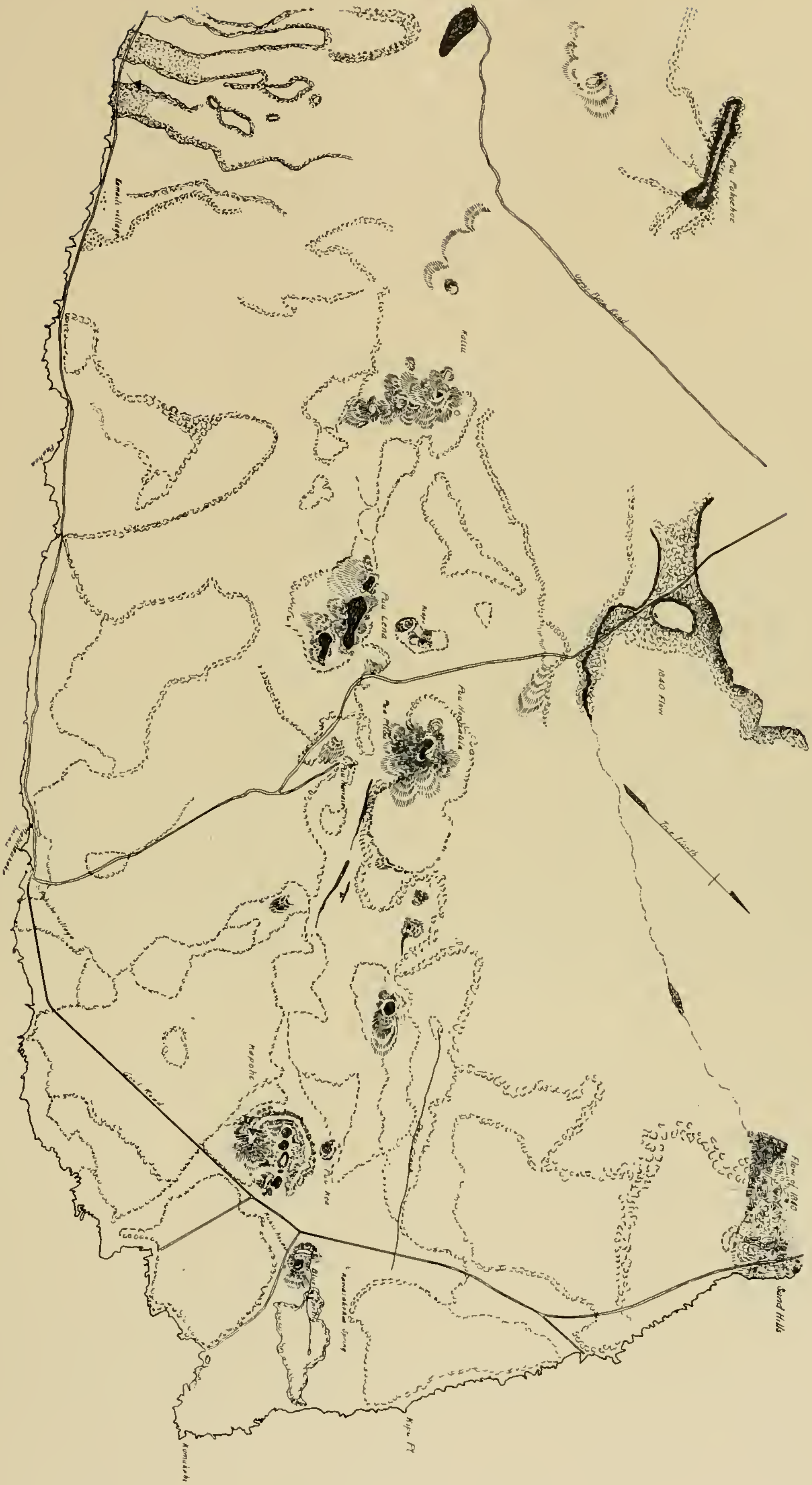

Pu Lena
1840 Flow
True North
Kapoho
Pu Kea
Flow of 1840
Sand Hills
Kipu Pt

FIG. 63. CRATER AT KAPOHO IN PUNA.

on an ancient flow, one of which was seven feet high, eighteen inches external diameter, and with a bore of eight inches. It was brittle, and on breaking it off, I found the hole was six feet deep, making its whole length thirteen feet. Others of the same height were near by, and their sides were always thicker towards the source of the flow, Externally they are rough like aa, but the top was smooth and sometimes projected like an umbrella. Where several were in close proximity a slab of lava was supported like a roof on columns (see Fig. 43). The lining of the tube was smooth and much more compact and vitreous than the exterior. The trees which served as cores, if not burned have entirely decayed, and were mostly tree ferns, although I think that I detected some ohias. I followed the stream down some distance to learn the cause of its subsidence, which must have been rapid, and found that a fissure had opened and swallowed most of the lava. Judging from the great size of the trees growing over its surface, the flow must be quite ancient. The surface of the casts gave fresh indication of the process by which aa is formed and seems to prove that the more refractory particles of the lava cool at an appreciable time before the general molten mass ceases to be liquid, much as the less soluble salts in a saline solution crystallize first on cooling;

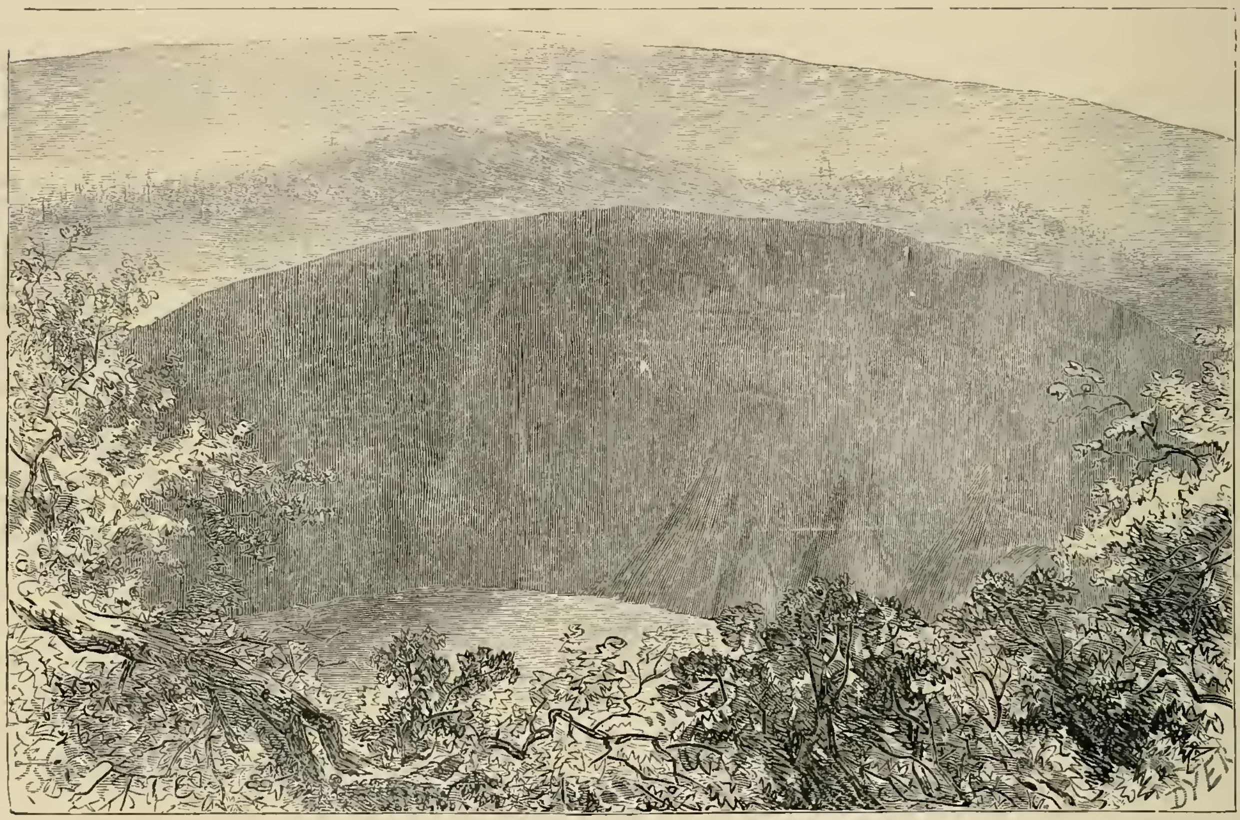


FIG. 64. CRATER MAKAOPUHI IN PUNA.

here the first cooling part is not fully crystalline, and if the mother liquor is withdrawn the rough already solidified part remains as aa.

Tuesday I went with my boy Ioane to explore the woods. As I followed a path made by the pulu pickers through the dense forest, I came upon a large hole on the edge of the path which proved to be the entrance to a cave of great depth. The path had been turned aside to avoid it, and in the dark it would be very dangerous. Such holes are common in this part of Puna, and natives occasionally disappear mysteriously. Brushing through the bushes I came to a precipice forming the edge of a crater nearly three-quarters of a mile in diameter and seven hundred feet deep. The sides were quite perpendicular, and in most places impassable. The bottom was level and gravelly, with a thin growth of ohia, and at the western end, directly under the wall, was a much deeper pit, indeed the deepest I had seen on Hawaii. Beyond this was a cone of some size, near which the eruption of 1840 reached the surface, first passing under the cone (see Fig. 64). Half a mile beyond this is another pit crater, smaller, and covered on the bottom with black lava. Following the line down in a southeasterly direction, I came to the steam cracks, which extend for several hundred feet, and since tradition existed have furnished the natives of the neighborhood with the means of cooking. The pahoehoe has been decomposed into a soft red muddy soil, covered with a hard crust, which may be raised in slabs. Under these are most beautiful crystals of sulphur in clusters, but too fragile to be removed.

Beyond these cracks was a much larger crater, elliptical, with a major axis a mile long and a depth of nearly five hundred feet. The perpendicular walls presented basaltic columns in various places, and at the west end were rent asunder affording an easy descent to the bottom, which was gravelly, level, and free from cracks or holes. The walls of all the craters that I visited were compact gray clinkstone in deep strata like the walls of Kilauea, and no recent lava was visible. Several dykes were seen at right angles to a line from Kilauea to Kapoho.[77] The line of these cones and craters may be seen on the map, but the principal group at Kapoho, near the coast, deserves more notice. These cones and craters seem to extend in several nearly parallel lines toward the mountain. One very interesting group much broken down, and apparently among the oldest, contains in its midst the beautiful Green Lake (Fig. 66). This occupies a deep crater but the water is of constant level, with no outlet and no apparent supply except from the rainfall on the sloping sides of the crater; it is about twenty feet deep, and although viewed from above the water looks very green, it is quite sweet and colorless in a glass. The natives assured me that its waters become yellow and then black during an eruption of Kilauea, a statement I much doubt. An adjoining crater contains many coconut trees: the walls between the craters of this group are thin as some of those in Hualalai, and like those pit craters are walled with stony lava and not tufa.

---

[77] These craters are now (1909) easily accessible by a good trail from the Volcano House. Many of these pit craters have the walls more or less covered with ferns, and one had the name Halema'uma'u (House of fern). From this perhaps arose the pedantic mistake of calling the Halemaumau (House that endures) of Kilauea by this other very inappropriate name. Pele had her Halemaumau, always there, however the form might change, and on her accustomed path to the sea she had her temporary lodging, a mere fern-covered house (Halema'uma'u). Father Coan, whose critical knowledge of the Hawaiian language was certainly as great as that of any one now living, recognized only Halemaumau in Kilauea, but more than one Halema'uma'u in Puna.

Half a mile from this group is a cone about two hundred and fifty feet high, and crowned with an ancient heiau or temple, and a clump of coconut trees. This cone is largely composed of lava, and is doubtless of great age as the soil is several feet deep upon it in some places. At its base is a large cleft in the rock some three hundred feet long and sixty wide, in which is a remarkably clear pool of warm water, twenty or thirty feet deep and of a temperature at the time of my first visit of 90°. Thirty-four years after I found it five degrees above the air temperature. At a later visit to test more accurately I found the pool occupied by a gang of Japanese field hands. The water is not mineral to the taste, but the dark-colored bodies of natives swimming in it seem almost wax-colored, and a white man in the pool resembles marble. The sound of water trickling down within the cliff is distinctly audible after a rain. Three-quarters of a mile from this is a deep narrow cavern into which one may climb guided by the natives with their bambu torches. There is a steep descent of nearly fifty feet to a pool of very warm water which is said to extend more than half a mile under ground.[78] All along the shore for twenty miles, warm springs are common near

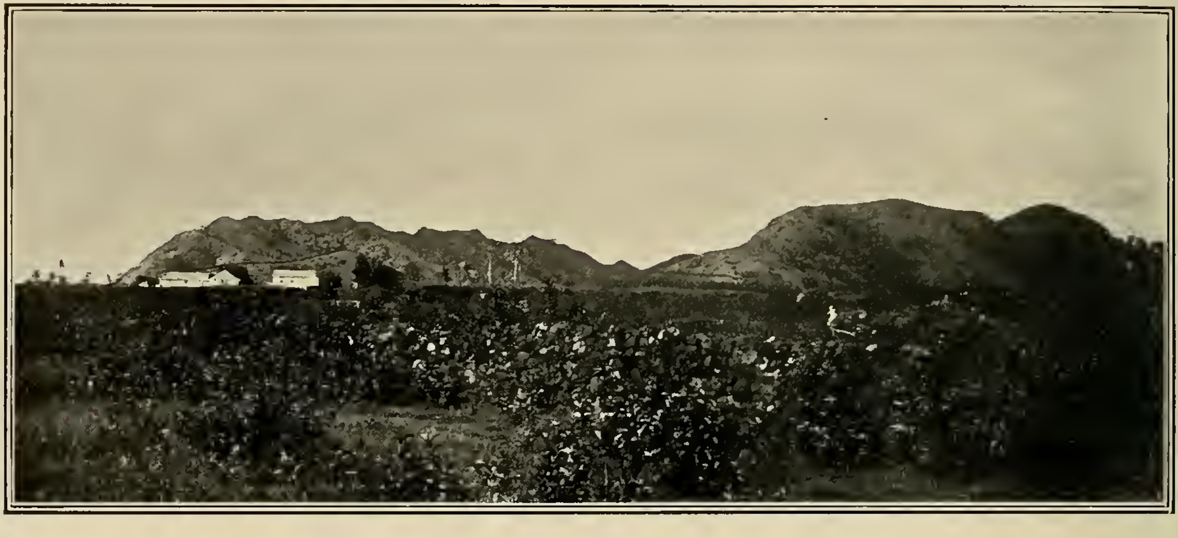


FIG. 65. VIEW OF THE PUNA CRATERS FROM THE NORTH.

---

[78] In 1864 the writer saw several natives swim nearly that distance holding their torches clear of the steaming water, and the indistinct view thus obtained of the cavern, led to the conclusion that it was a deep crack, over which a subsequent lava-flow had formed a roof.

low-water level. No mineral waters are found here, nor is there anywhere on the Hawaiian Islands even a carbonated or sulphur spring. The ground is mostly covered with aa through the whole district of Puna, and all the rain that is not held by this sponge-like form of lava sinks to the sea level and issues from clefts on the shore. As there is hardly any soil, it might be supposed that Puna would be a barren region, but the reverse is the case. Groves of coconut trees extend for miles, growing more thriftily than elsewhere on these islands, and the natives have no difficulty in raising pines, bananas and other fruits. The aa is often so rough that unshod horses cannot stand on it outside the beaten road, without a carpet of pandanus leaves or seaweed.

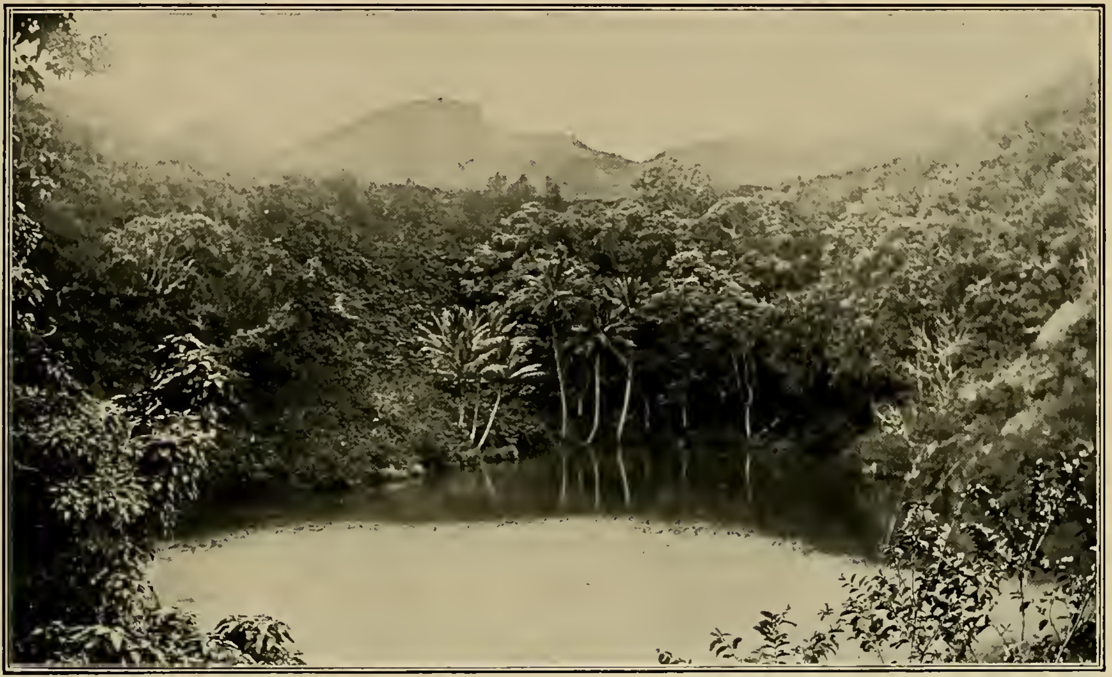


FIG. 66. THE GREEN LAKE.

The slopes of Kilauea are quite regular in this district, and many eruptions have flowed down this way; at least twenty may be counted in thirty miles. Tradition declares that formerly Puna was a fertile region surpassing in the productiveness of its soil any district of Hawaii, and that during the absence of the chief, Pele, the goddess of the volcano, left her abode in Kilauea to pay him a visit. From the appearance of the streams of lava it is not impossible that many of them were synchronous, and that the larger portion of Puna was overwhelmed by the same eruption of Kilauea. None of the lavas of Mauna Loa have flowed this way. The pandanus flourishes greatly in this region, and innumerable caves found in the streams of ancient lava afforded the weavers cool and damp shelters well adapted to mat-making. Other caves whose roofs have not fallen have, from early times been a favorite depositary for the remains of the dead.

This digression from the chronological record of the Kilauean eruptions seemed necessary to explain the geography of the emptyings of its great cauldron, and will save time later when our notes are more condensed. I have been through Puna many times, and have tried to trace from native tradition this or that eruption in the lava flows that, generally speaking, look all of an age, but I am not certain that any prior to that of 1840 can be correctly identified. I put no faith in the identification of that of 1823 on one of the government surveys, for Ellis closely questioned the natives and could not hear of any outbreak from the natives of Puna who met him both in Puna and Hilo. That or any other may be the flow of 1823 if that flow came to the surface on the Hilo side, which it probably did not, so far as the evidence goes.[79]

FIG. 67. BLUE POOL.

1868 Since 1865 the great crater of Kilauea had been slowly filling up by the overflow of the northern lakes of 1864, and of various cones between these and Halemaumau until the whole central portion was considerably elevated.[80] Mauna Loa had also been more or less active since visited by Mr. Horace Mann and myself in 1865. Then the great summit crater Mokuaweoweo was quite still, and apparently cold and extinct, exhibiting hardly any signs of recent action; only on one of the lower walls a little steam floated up from the cracks below. No one has ascended this mountain since our visit three years ago, but from the shores the glare of its crater has been distinctly seen more than once in the interval. As it was winter, and the snows and storms rendered the ascent dangerous, no one attempted it, and as no lava stream flowed down, little attention was paid to these distant and temporary volcanic displays.

---

[79] The evidence strongly favors the identification of the short flow on the other side of Kilauea as that of 1823, and I have so considered it on the map of Hawaii herewith.

[80] The following account was published in 1869 in the Memoirs of the Boston Society of Natural History, vol. i, 564. I have here united the eruptions of the two volcanoes, as the same cause seems to have effected both, and the subsidiary phenomena—earthquakes, landslide, and tidal wave, belong to either or both.

During the past ninety years ten great eruptions have taken place on Hawaii, averaging one for every nine years, the last occurring in 1859, when a large stream of lava flowed from Mauna Loa some sixty miles into the sea. The lava had accumulated in the reservoirs which supply this mountain and was ready to break forth. To this brief statement of the condition of the Hawaiian volcanoes previous to the present outbreak, may be added the fact that the season had been exceedingly rainy, and the mountain streams were much higher than usual.

March 27, 1868, about half-past five in the morning, persons on the whale ships at anchor in the harbor of Kawaihae saw a dense cloud of smoke rise on the top of Mauna Loa, in one massive pillar, to the height of several miles, lighted up brilliantly by the glare from the crater Mokuaweoweo. In a few hours the smoke dispersed, and at night no light was visible.[81]

About ten o'clock A.M. on the 28th (Saturday), a series of earthquakes began, which has continued at intervals nearly eight months. The shocks commenced early in the morning; the first was followed at an interval of an hour by a second, and then by others at shorter intervals and with increasing violence, until at one o'clock P.M. a very severe shock was felt all through the southwest part of the island. From this time until the 10th of April the earth was in an almost constant tremor. In the district of Kona as many as fifty or sixty distinct shocks were counted in one day; in Kau over three hundred in the same time; while near Kilauea and about Kapapala it was difficult to count them. It is said that during the early part of April two thousand distinct shocks occurred in Kau, or an average of one hundred and forty or more each day. The culminating shock occurred on Thursday, April 2d, at twenty minutes before four in the afternoon. Every stone wall, almost every house, in Kau was overturned, and the whole was done in an instant. A gentleman riding found his horse lying flat under him before he could think of the cause, and persons were thrown to the ground in an equally unexpected manner. Mr. F. S. Lyman was at Keaiwa, near the point where the motion was greatest, between that and the centre of vibration, which was not very distant, as the angle of emergence was almost 90°, or nearly coincident with the seismic vertical, and he reported as follows:

---

[81] Rev. J. D. Paris writes from Kona, Hawaii, "In less than half an hour these columns of smoke had shot up along the slope of the great mountain southward to the distance of ten or fifteen miles. We thought it was from a stream of lava.....but the clouds soon shut in the whole mountain, and nothing more was seen during the day..... During the whole night no light nor smoke were to be seen. All was clear and still as death."

> First the earth swayed to and fro north and south, then east and west, round and round, then up and down and in every imaginable direction, for several minutes; everything crushing around us; the trees thrashing about as if torn by a mighty rushing wind. It was impossible to stand, we had to sit on the ground, bracing with hands and feet to keep from rolling over. In the midst of it we saw burst out from the pali [precipice] about a mile and a half to the north of us, what we supposed to be an immense river of molten lava (which afterwards proved to be red earth), which rushed down its headlong course and across the plain below, apparently bursting up from the ground, throwing rocks high in the air, and swallowing up everything in its way, trees, houses, cattle, horses, goats and men, all in an instant, as it were. It went three miles in not more than three minutes time, and then ceased. Some one pointed to the shore, and we ran to where we could see it. After the hard shaking had ceased, and all along the sea-shore, from directly below us to Punaluu, about three or four miles, the sea was boiling and foaming furiously, all red, for about an eighth of a mile from the shore, and the shore was covered by the sea. We went right over to Nahala's hill with the children and our natives, to where we could see both ways; expecting every moment to be swallowed up by the lava from beneath; for it sounded as if it was surging and rushing under our feet all the time, and there were frequent shakes. In places the ground was all cracked up, and every rock or pali that could fall had fallen. At Hilea we saw a small stream of black smoking lava, and outside of Punaluu a long black point of lava slowly pushed out to sea and soon disappeared.

Ten miles to the southwest of Keaiwa, at Waiohinu, the great stone church was levelled to the ground (Fig. 68), and nearly all the other buildings were destroyed. The earth opened all through the district, and often left dangerous fissures, although it usually closed. The meizoseismic curve (or that of maximum overthrow) seems to have been elliptical, with a major axis of about ten miles in a southwest and northeast direction, while the isoseismic curves were rather crescent-shaped, having their convexity towards Mauna Loa. In Kona the shocks were severe, but less so than in Kau; At Kohala they did very little damage, not even injuring the tall chimney of the Kohala sugar mill; while at Hilo, on the other side of the mountains, the violence of the vibrations was about the same as in Kona. The mountains seem to have deadened the shock, and simply transmitted it through their solid cones to the axes of the other islands of the group, where the shock of April 2nd was felt as a vibration from the central mountain to the sea. This was the case even in Kauai, nearly three hundred miles distant from the supposed seismic vertical. No damage was done except in these southern districts of Hawaii, where the undulations seemed to bend around the base of the mountain, forcing the isoseismic curves far from the meizoseismic curve in Kau.

At Hilo, although the shock was not so severe as at Waiohinu, more damage was done, for the houses were larger and more numerous. A correspondent writes: "I was coming from the tannery to my store, when I heard a loud, rumbling noise like a number of iron carriages drawn over a rough road by wild horses. Soon the shock came. The horses in the pasture took fright, and ran and snorted, the dogs howled, and the pigeons flew about as if somebody had been shooting at them. The shock lasted a good while, how long I cannot say, but long enough to make me feel sea-sick, and it was with difficulty that I could stand. All the stone walls about the town were flat. Fissures opened, and the brooks ran mud; in one place a fissure opened about a foot, and when it closed the two sides were several inches from coincidence."

The land-slide referred to by Mr. Lyman, is well described by the Rev. T. Coan, whose letter will be given presently. The most destructive feature of the whole catastrophe, however, was the sea-wave which swept the shores of Hawaii from Kahuku to Kapoho and was felt at the most distant shores of the group. At Hilo the sea receded a hundred and fifty or two hundred feet, and when it returned rose about ten feet above high-water mark. Along the shore between Kapoho and Kalae, villages were swept away, and even heavy stone houses disappeared before the destroying waves.

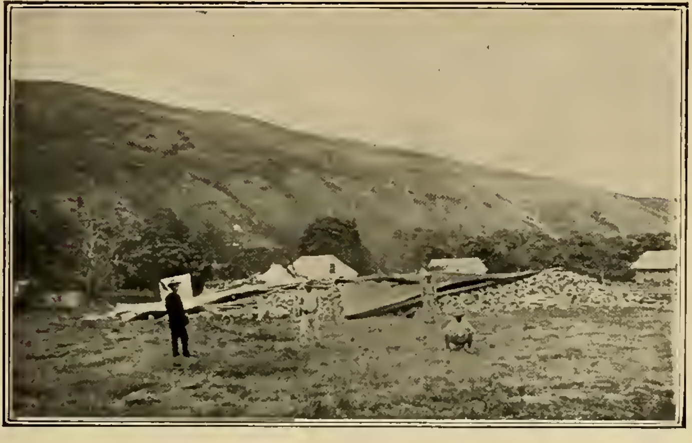


FIG. 68. CHURCH AT WAIOHINU WRECKED BY EARTHQUAKE.

The earth continued to vibrate, but the shocks were not very severe, until on Tuesday night, April 7th, lava broke out in Kahuku, and flowed some ten miles then into the sea. The exact locality of the flow was afterwards determined by Mr. Coan. The schooner Oddfellow was cruising along the coast of Hilo, Puna and Kau, about the time of the sea-wave and the eruption, and from the report of a passenger the following notes are extracted. As she touched at many points, the information is of considerable interest.

Saturday, March 28.—Lakes in Kilauea active. Portion of the southwest cliff thrown down. *Sunday, 29.*—Shakes frequent but slight; one of them very peculiar in its motion commencing from northwest to southeast, shook a moment, and then shifted to northeast and southwest. North lake quite active. Shocks appear to have been stronger on the beach at Keauhou than they were at the volcano. *Thursday, April 2.*—Severe shock at Hilo. Keauhou and other villages in the neighborhood swept away. *Friday, 3.*—Shocks very violent in Kilauea. Fire in Kilauea iki, the south lake terribly active, and enlarging rapidly. *Saturday, 4.*—Saw fire on the hills at Kapoho; could not tell whether it was a lava-flow or not. *Sunday, 5.*—Made Kealakomo, Puna, at daylight. The houses nearest the beach gone; same at Kahue. All swept clean at Apua. Reached Keauhou, Kau, at seven A.M. and anchored. Found the anchorage and boat-landing all right. Every building, eleven in all, washed away; not a stick or stone of them left standing. Portions of the wreck washed inland over the flat about eight hundred feet; heavy ohia sticks and a large spar were carried that distance. In some places the ground appeared to have sunk, and the sea was flowing a fathom deep where houses formerly stood. Men who were at work near the beach at the time of the shock (April 2), say that the walls of stone buildings were thrown outward by the shock, which was so severe that they were themselves thrown off their feet; then the sea came pouring over the rocks which lined the shore, and they escaped being overtaken by the hardest kind of running. No one was hurt. A messenger from Kilauea reports that hardly a sign of fire was to be seen in the crater. Got under way and ran down to Punaluu. *Monday, 6.*—Too rough to attempt a landing. The stone church and all the other buildings near the sea gone. At Ninole but three houses were left. Smoke or steam is issuing from the hills back of Hilea. Came to anchor at Kaalualu at noon. The houses, wharf, etc., all gone here, and the rocks inland strewed with the wreck for a distance of six or eight hundred feet. Dense clouds covered the summit of Mauna Loa, but no sign of fire, and no reflection from Kilauea. *Tuesday, 7.*—The deck covered this morning with very fine ashes. Procured animals, and rode along the beach to the south point. The sea had been inland in some places, a hundred and fifty yards, and the whole coast was lined with house timbers, lumber, broken canoes, dead animals that had drifted ashore. At Halii found the body of a native woman lying among the rocks, the right leg bitten off at the knee, and the body otherwise horribly mutilated by the sharks. The shock of the earthquake was evidently slight in this direction, for many of the stone pens were not much damaged, and at Kalae, the extreme southerly point, there was no sign of any disturbance. Weighed anchor at three P.M., and ran past Kalae. At six P.M., when the point was about ten miles astern, bearing E. by S., a volume of flame shot up from the mountain Loa, in what appeared to be the neighborhood of Kahuku. The heavens were lighted up at once, and the reflection extended rapidly in the direction of Waiohinu and Kaalualu. After the first outburst we saw the fire but once or twice, and then it appeared to be the grass burning on the edge of the cliff which extends inland from the south point. There was no flow of the lava over the cliff, nor toward Kona, and the stream probably ran down on the Kahuku flat or between there and Waiohinu to the neighborhood of the Kaalualu landing. It reached the sea somewhere in that direction at nine and a half P.M., when an immense body of steam at once arose, through which flashes resembling lightning were constantly darting as long as we were in sight. The top of the mountain was concealed by the dense clouds of smoke.

From a schooner at anchor off Lanai the light of this lava-stream was seen about midnight, over the mountain, while flashes like chain-lightning shot up into the clouds. From Lahaina the same light was seen, and the next day a column of smoke in the same direction. From Kona the light was first seen about eleven P.M. The Rev. S. E. Bishop, president of Lahainaluna Seminary on Maui, contributes the following observations:

During the night of April 7th a bright but varying crimson light over the volcano was visible from the Seminary at the distance of one hundred and twenty statute miles as measured on Wilkes' chart. This light was a reflection from a mass of cumulus cloud through which vivid lightning was constantly darting. After daylight and through the morning of the 8th, this stupendous column of cloud was visible pouring rapidly up to the ether, with ever varying shape. It was usually well defined on the westward side, where it, at times, presented a perpendicular wall of miles in height. On the east it was ill-defined. Above, it often spread out, especially toward the east, as if borne off by the southeast wind of the upper air. The base, so far as visible, appeared to be commingled with murky brown strata. The apparent altitude of this cumulus above the horizon, when at its highest was 3°30′ which reduced for a base of 120 miles with 500 feet altitude of the point of observation, gives a height of 7.8 miles. This morning, the 9th, our atmosphere is charged with smoky haze, and a very distinct odor of sulphurous acid.

At Kapapala, on the 7th, the ground was still in violent agitation, with a long undulatory motion. At night a very large flow of lava was seen running down the mountain to the sea. The next day smoke was seen issuing from cracks in this neighborhood. Mr. H. M. Whitney visited the scene of the eruption on the 10th, and from him we learn the following particulars:

> As we approached the flow the rumbling noise became more and more distinct. The ground was covered with what appeared to be cinders, but on examining them we found they were fragments of [basaltic] pumice-stone which had been carried by the wind a distance of over ten miles. Mixed with these cinders was *Pele's hair*, which we found floating in the air, and when it was thick we had to hold our handkerchiefs to our nostrils to prevent inhaling it; our clothes were frequently covered with it. We hurried on and reached the flow shortly after noon, when from a ridge to the west of it the whole scene opened before us. Between us and the crater was a valley five hundred yards wide and ten miles long, which had recently been overflowed throughout its entire breadth and length from the mountain to the sea where it widened to two or three miles. The lava was of the smooth or pahoehoe variety, from ten to twenty feet deep, and partially cooled over, though flames, smoke and gas escaped from numerous crevices. On Tuesday afternoon, April 7th, at five o'clock, a new crater, several miles lower down than that referred to, and about two miles back of Captain Brown's residence, burst out. The lava stream commenced flowing down the beautiful grass-covered plateau, towards and around the farm-house, and the inmates had barely time to escape with the clothes they had on; the path by which they escaped was covered with lava ten minutes after they passed over it.
>
> On ascending the ridge we found the eruption in full blast. Four enormous fountains, on a line a mile long, north and south, were continually spouting up from the opening. These jets were blood-red, and yet as fluid as water, ever varying in size, bulk and height. Sometimes two would join together, and again the whole four would be united, making one continuous fountain a mile in length. From the lower end of the crater, a stream of very liquid, boiling lava flowed out and down the plateau, a distance of two or three miles, then following the road ran down the precipice at an angle of about 30°, then along the foot of the pali or precipice, five miles to the sea, the stream being about eight or ten miles in length, and in some places half a mile wide. One peculiarity of the spouting was that the lava was ejected with a *rotary motion*, and as it ascended both lava and stones rotated always in one direction towards the south. This was the only stream which reached the sea, and flowed into it at Kailikii. It lasted only five days, the eruption ceasing entirely on the night of the 11th, or morning of the 12th. During its continuance, the atmosphere was filled with smoke so dense that the sun appeared like a ball of fire, and the whole island was shrouded in darkness. The smoke came from the rent or crater, and was highly charged with sulphur.
>
> As the lava entered the sea, clouds of steam and smoke rose up, and flames of bluish fire were emitted, rising from the water to a height of from ten to twenty feet. During the night we were at the volcano, the air was highly charged with sulphurous gas and electricity, and frequent flashes of lightning were seen directly over the lava stream, accompanied with short claps of thunder. These flashes were also observed less frequently further up the mountain. About four thousand acres of good pasture land were destroyed, besides which the lava ran over an immense district of worthless land. On the night of the 6th of April, prior to the eruption, there was a shower of ashes and pumice-stone, which came from this crater, and covered the country to a distance of ten or fifteen miles each way. Generally the ashes were not more than one or two inches in depth, but in some places were found to be fifteen. The pumice-stone was very light, and appears to have been carried by the wind a great distance. Pieces two and three inches in diameter floated ashore at Kealakeakua, forty-five miles distant.

During the early part of April an observer in Kona kept a careful record of the principal shocks felt there, but in other places no observations were made. The only certain thing, among various and somewhat extravagant reports, is that the vibrations were very frequent and not very severe. In some places they were almost silent, but usually accompanied by subterranean detonations and rumblings, with a noise as of boiling, surging waves in the bowels of the earth. No observations were made on the gases said to have been emitted from some of the fissures.

When the eruption of lava was made known at Honolulu, many residents at once set out for Hawaii, and among them a gentleman of distinguished attainments in botany, Dr. William Hillebrand, who has given us so accurate and full an account of what he saw in passing through the disturbed region that it seems worthy of a more permanent record than would be its lot in the local newspaper in which it first appeared. He writes as follows:

I started from Hilo with a few friends for Kilauea April 17th; descended the crater on the 18th; examined the extensive fissures near the Puna road on the 20th; the so-called mud-flow on the 21st; and the lava streams in Kahuku on the 23rd. On the 24th we crossed the lava stream on the road to Kona, and reached Kealakeakua Bay on April 26th.

Of Hilo I have little to say, as your correspondents have communicated to you the most remarkable events from that place. I saw several fissures in the earth near Wahiawa River, of from eight inches to one foot in width, which were caused by the earthquake of April 2nd, and run in the direction of Mauna Loa. The earthquake waves all moved from southwest to northeast, and overturned movable objects standing at right angles with that line. A heavy book-case in the Rev. T. Coan's library, holding that relation to the wave, was overturned, while another heavy case, filled with shells and minerals, which stood parallel to the wave, remained standing.

Kilauea.—The ground around the crater, particularly on the eastern and western sides, is rent by a number of fissures, one near the Puna road more than twelve feet wide, and very deep; others of lesser size run parallel to and cross the Kau road, so as to render travel on it very dangerous. The lookout house is detached from the mainland by a very deep crevasse, and stands now on an isolated overhanging rock, which at the next severe concussion must tumble into the pit below. Many smaller fissures are hidden by grass and bushes, forming so many traps for the unwary. The Volcano House, however, has not suffered nor is the ground surrounding it broken in the least. From the walls of Kilauea large masses of rock have been detached and thrown down. On the west and northwest sides, where the fire had been most active before the great earthquake of April 2nd, the falling masses probably have been at once melted by the lava and carried off in its stream, for the walls there remain as perpendicular as they were before; but that this part of the wall has lost portions of its mass, is shown too evidently by the deep crevices along the western edge just spoken of, and the partial detachment in many places of large prisms of rock. But it is on the east and northeast wall particularly, that the character of the crater has undergone a change. Along the descent on the second ledge large masses of rock, many, more than one hundred tons in weight, obstruct the path and form abutments to the stone pillars—small buttress hills similar to those observed in front of the high basaltic wall of Koolau, Oahu. So also in the deep crater itself the eastern wall has lost much of its perpendicular dip, and has become shelving in part.

The crater itself was entirely devoid of liquid lava; no incandescence anywhere; pitchy darkness hovered over the abyss the first night. I say the first night, because during the second night of our stay between twelve M. and one A.M., detonations were heard again, and light reappeared for a short time in the south lake Halemaumau. White vapors of steam issued from the floor in a hundred places, but of those stifling sulphurous and acid gases, formerly so overpowering in the neighborhood of the lakes and ovens, only the faintest trace was perceived here and there.

The heat was nowhere so great that we could not keep our footing for a minute or more, although in many places it would forbid the touch of the bare hand. The great south lake Halemaumau is transformed into a vast pit, more than five hundred feet deep, the solid eastern wall projecting far over the hollow below, while the remaining sides are falling off with a sharp inclination, and consist of a confused mass of rough aa. More than two-thirds of the old floor of Kilauea has caved in, and sunk from one hundred to three hundred feet below the level of the remaining floor.

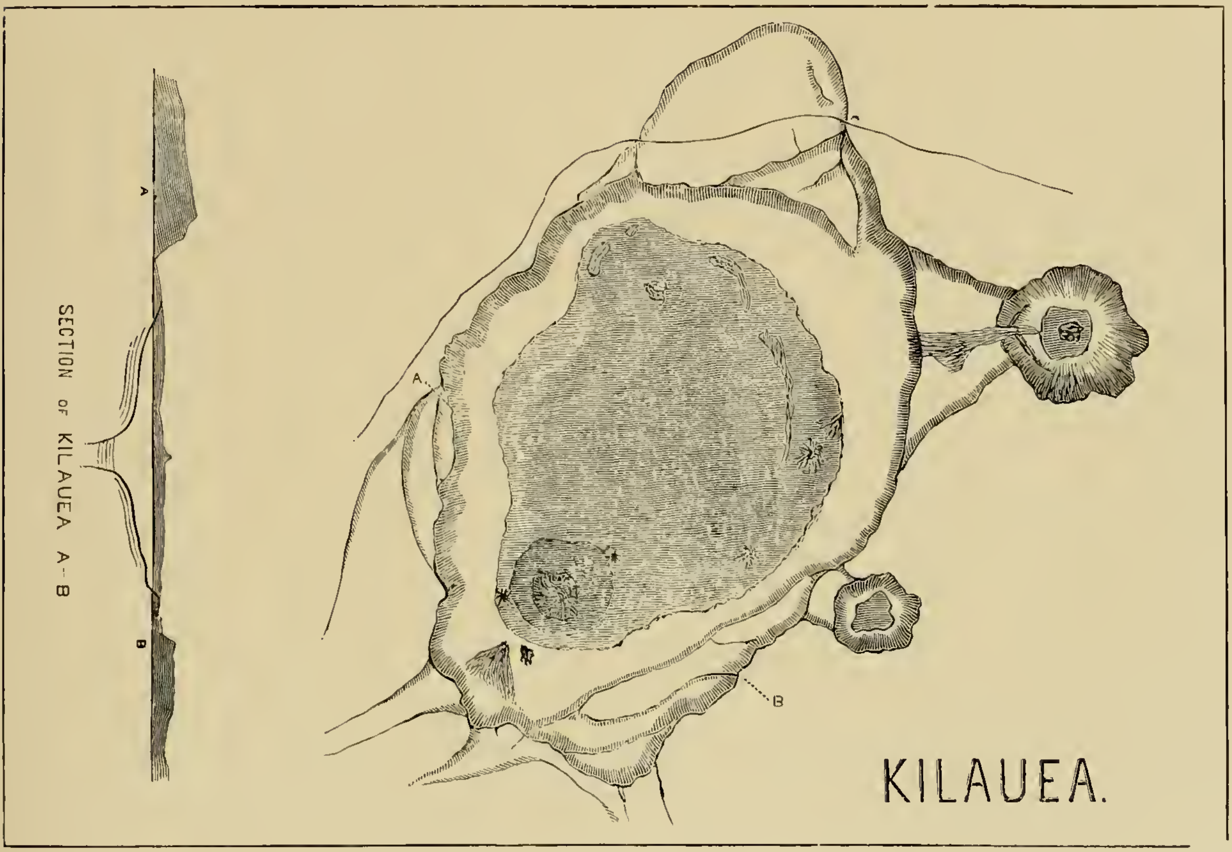


FIG. 69. KILAUEA AFTER THE ERUPTION OF 1868.

The depression embraces the whole western half, and infringes in a semicircular line on a considerable portion of the other half. This is greatest in the northern, and rather gradual and gentle in its southern portion. Entering on the depressed floor from the southern lake, it was some time before we became fully aware of its existence, and it was only on our return from the northwest corner, where it is deepest, that there presented itself through the mist in which we were enveloped, a high wall of three hundred feet, grotesque and fanciful in outline. At first we were quite bewildered, fancying that we beheld the great outer wall of the crater. On nearer approach we soon satisfied ourselves that this singular wall represented the line of demarcation of a great depression in the floor of the crater—a fact that surprised us the more, as a bird's eye view from above had altogether failed to apprise us of its existence. As we had been informed that the principal activity of the crater before the great earthquake had been in the northwest corner, we proceeded in that direction on leaving the south lake. Having arrived at about the middle of the depression a considerable rise in the ground presented itself on our left—to the west. Having ascended this, we found ourselves at the brink of a fearful chasm, which fell off on our side with a beetling wall to the depth of several hundred feet and extended about half a mile from north to south. Very hot air rose from it. Around it, towards its northern extremity, the lava is thrown up into an indescribable confusion; pile upon pile of aa gorge and ridge by turns.

The caving in of the floor seemed to be still in progression, for twice during our exploration of the crater, our nerves were disturbed by a prolonged heavy rumbling and rattling noise, as from a distant platoon-fire of musketry, coming from the northwest corner.

Kilauea iki, which in 1865 was covered with shrubs on its side and partly on the bottom, was now overflowed with black, shining lava. It has been free from fire since 1832.

Thus far as to what we have seen. Now allow me to relate what I learned from Kaina [the District Judge, and a most intelligent Hawaiian], who has resided near the volcano without interruption for the last five months, and whose strong nerves sustained him during the fearful catastrophe introduced by the earthquake of April 2nd. He and the Chinaman who keeps the house, were the only persons who remained at Kilauea. He says that for two months preceding the first shock, namely, from January 20th to March 27th, the crater had been unusually active; eight lakes being in constant ebullition and frequently overflowing. During all this time (the date of its first appearance could not be ascertained exactly), there was in the northwest corner a blow-hole, from which at regular intervals of a minute or less, with a roaring noise, large masses of vapor were thrown off, as from a steam engine. This ceased about the 17th of March. At the same time the activity of the lakes became greatly increased, and Kaina anticipated mischief. March 27, the first shock was perceived. Two days later Mr. Abraham Fornander found the bottom of the crater overflowed with fresh lava, and incandescent.

Thursday, April 2nd, at a few minutes past four P.M., the big earthquake occurred, which caused the ground around Kilauea to rock like a ship at sea. At that moment there commenced fearful detonations in the crater; large quantities of lava were thrown up to a great height; portions of the wall tumbled in. This extraordinary commotion, accompanied with unearthly noise and swaying of the ground, continued from that day till Sunday night, April 5th, but *from the first the fire began to recede.* On Thursday night it was already confined to the regular lakes; on Saturday night it only remained in the great south lake, and on Sunday night there was none at all; Pele had left Kilauea. The noises now became weaker, and were separated by longer intervals. By Tuesday quiet reigned in Kilauea. On that afternoon the lava burst out at a distance of forty miles, southwest, in Kahuku.

April 2nd, from six to ten P.M., Kaina observed fire in the direction of Puna, which, at the time, caused him to believe that the lava had found a vent again in that direction, as it did in 1840; but he subsequently satisfied himself that it was only a reflection from lava in Kilauea iki. It was not seen afterward.

In Kapapala we are told that fire had been seen several nights in a southeast direction, and that natives had reported flowing lava there. We rode over in the morning of April 20th. At a distance of five miles from Mr. Reed's dwelling, where the Puna road turns off from the Kilauea road, heavy clouds of white vapor were seen to issue from the bush, which sparsely covered the pahoehoe, makai[82] of the road. Half an hour's ride brought us up to the place, but we were obliged to leave our horses some distance before reaching the spot, on account of fissures. After having crossed a number of them, heading for the heaviest cloud of vapor, we at last came to a deep crevasse in the pahoehoe, at least twenty-four feet in width, no bottom visible. It narrowed and widened out in places, but nowhere was less than eight feet wide. Its length we estimated at four hundred feet.

---

[82] Makai is the Hawaiian for "towards the sea". [486]

Parallel with this great crevasse, constituting a belt about six hundred feet in width, were a number of smaller ones on each side, diminishing in size with distance from it, from six feet to a few inches. From the larger openings in the former, heavy white columns of hot steam issued, which had a decidedly alkaline smell. Smaller jets of vapor to the number of thirty, rose from the smaller fissures. We could not discover fire in any place, but it is very probable that during dark nights the reflection of the underlying lava should be thrown up, for as the steam did not seem to contain combustible material, it is unlikely that the light seen should have been produced by it. The mean direction of all the fissures was N.E. 9° N., S.W. 9° S., or nearly the direction of a line connecting Kilauea with Waiohinu and Kahuku. The distance of these fissures from Kilauea is thirteen miles.

As in this district the earthquake of April 2nd culminated to its greatest intensity, so as even to rend in twain the frame-work of a mountain-side, and hurl down on the plain a portion of its flank, it is necessary to give a short description of the country in order to insure a proper understanding of the disturbance. The locality in question is that comprised between the ranch stations of Messrs. Reed and Richardson, on the east, and Mr. F. S. Lyman on the west, a distance of five miles. The government road connecting these two places runs through a fine grassy plain, which has a very gentle fall towards the sea, its elevation being about 2000 feet. Into this plain project from the slope of Mauna Loa three parallel hills or spurs, each about one mile in length, and from 800 to 1800 feet in height. They include two broad valleys between them. The upper portions of these valleys rise with a steep incline towards a ridge which runs at right angles with the spurs, and is covered with a dense pulu forest, which extends far up the gentle slope of the dome of Mauna Loa. In the second one of these valleys—that next to Mr. Lyman's—the so-called mud-flow took place, but very extensive land-slides, confined simply to the loose earth and conglomerate, also occurred in the other valley.

The ground around Reed and Richardson's station is torn up into numerous small cracks and fissures, running in every direction. Some are large enough to engulf horse and rider, a fact which actually occurred a few days after the earthquake. A large cistern, built in solid masonry and covered with an arched stone roof, was rent to pieces, and the roof entirely broken away. Not a single stone fence is standing; their places are indicated by flat belts of stone on the ground. The dwelling house—a good wooden framed one—exhibits a wrench across its roof, so that the gutters empty themselves in the sitting room; the cook-house is thrown off its foundation; other out-buildings are completely overturned; and of the grass houses, some are smashed down, others greatly inclined. But all these signs of destruction are thrown in the shade by the grandeur of the force which shook off the side of the pali, burying in a minute thirty-one human beings, many hundred head of cattle, and entire flocks of goats, and ending four miles from its beginning in a mighty river of mud. Before reaching this mud-flow from Reed's house, we passed two considerable streams of muddy water, of a reddish-yellow color, emitting a strong odor of clay, such as may be perceived in potteries. Both streams have their origin in the land-slide of the first valley. When we passed them again, two days later, they had nearly disappeared; they evidently owed their origin to the drainage of the fallen mass. The mud-flow is met with three miles from Reed's. It projects itself from the spurs of the hills two miles down in the plain; begins at once with a thickness of six feet, which, towards the middle, where it forms a small hill, rises to thirty feet; averages about three-fourths of a mile in width, and contracts towards its end. From this end a long queue of boulders bears witness to the violent action of a torrent which shot out of the mud after it was deposited, and which has since perpetuated itself in a stream of some size, quite muddy, and emitting the above mentioned pottery odor when we saw it first, on April 20th, but perfectly clear and inodorous when we passed it three days later. A little higher up a koa grove gives still stronger evidence of the strength of the propelling force. The trees first seized are snapped off and prostrate, yet the mud in that place is only a few feet deep. The mass itself is nothing but the loose red soil of the mountain side, with a good sprinkling of round boulders, with here and there stumps of trees, ferns, *hapuu* and *amaumau*, and entire lehua trunks. Near the lower end a vigorous, healthy taro-plant stood erect in the mud as if it had been planted there. From the sides of the mass protruded portions of the bodies of many cattle and goats, overwhelmed in their flight; a gain of one second of time might have saved them. The surface of the mud in this lower course was rather smooth, as if it had been forced down by the agency of water, and it was still so soft that the feet sank deep into it.

After we had flanked it for some distance along the side of the hill, the mud became solid enough to bear our weight, and we walked upon it to the head of the pali. The surface gradually became more rough; the boulders increased, and detached portions of earth and stone were scattered beyond its borders, which also flattened out gradually. The ascent soon became steep, and here, on a short spur, just in the middle of the mud, stands a native house on an island of grass and kalo, flanked by two trees. A poor woman who happened to be in it at the time of the outbreak, escaped the awful fate which doomed the remaining members of her family, and was removed from her perilous situation a few days after, when the crust had become solid enough to bear a man's weight.

As we went on the mass became more rough and hard, tree trunks and boulders increased, even angular rocks appeared, until at last the mud ceased entirely and gave place to a sea of huge rocks, all angular and exhibiting fresh fractures, large trunks of trees crushed between and under them, and streamlets of fresh, clear water meandering between them. This continued for the last three hundred feet of rise, and ended in a perpendicular wall of solid rock, some twenty feet high, after having climbed which, we reposed under the refreshing shade of tall fern trees, for we had entered at once the great pulu forest. Seated on the trunk of a prostrate tree, we could survey the whole scene of devastation we had just traversed. Immediately at our feet the rocky framework of the pali was torn up, and its contents turned topsy-turvy in dire confusion. The rocky wall we had just climbed, continued until it reached the sides of the two flanking hills. A perpendicular cut in the sides of the latter laid open some forty feet of red earth and conglomerate. On looking behind us we saw that the rock we were resting on was separated from the mountain by a deep crevasse, parallel to the wall, and only partly visible, as it extended under the dense trees. To our left a clear sparkling mountain stream leaped in a bounding cascade over the crag, and after losing its course amid the maze of rocks, gathered itself again, flowing over the solid bed-rock in a deep gorge cut in the mud. This stream had existed here before, but ere it reached half down the pali, became lost in the soil. It can easily be imagined what an amount of subsoil water must have been deposited here. Bearing this in mind, and the great depth of soil and conglomerate on this slope, as indicated by the cuts in the hill-sides, there seems to be no great difficulty in explaining how such enormous masses of earth, at first propelled horizontally through the air, hurled down the valley by the tremendous force which tore off the side of the mountain, should then have been seized by the propelling force of the now liberated subsoil water and carried in a mighty stream far beyond the place where at first they were deposited.

All this destruction was the work of the great earthquake of April 2nd. During the five days preceding it, over one thousand shocks had been counted. On that afternoon Mr. Harbottle, at Reed's, with his men, was driving cattle across the hill towards Hilo, when suddenly the earth shook violently and a great detonation was heard behind them. Horses and cattle turned round involuntarily. The whole atmosphere before them was red and black. In a very short time this subsided—some say in one minute, others in five minutes; but a black cloud continued to hover over the scene for some time. From that Thursday to Sunday the earth constantly rocked and swayed; the hills seemed to alternately approach and recede. Most people became seasick. Strange roaring and surging noises were heard under the ground. When the ear was applied to the earth it would often receive a distinct impression as if a subterranean wave struck against the earth's crust. The prevailing direction of the earthquake waves was said to have been from northeast to southwest.

Here follows a portion of Dr. Hillebrand's account that covers ground already trodden by Mr. Whitney. After he arrived at Kahuku his account gives us the appearance of the lava after the flow had ceased. He continues:

> As the principal interest was the discovery of the main source of the stream, we at once went to that part of it, where, according to common report, the lava had issued. A very light, dark brown, glistening pumice stone lay scattered about long before the lava was seen. Near the flow it increased so much that the animals' feet sank deep into it at every step. We soon reached the ridge of a hill from which we surveyed the place where, according to our guide's account, the fountains of lava had been seen. The upper portion of the lava stream fills a broad valley or depression, between two parallel low hills of not more than three hundred feet in height, both running almost due north and south. From the western one of these hills Mr. Whitney had witnessed the eruption. From the eastern hill we in vain looked for a crater or cone. We did not make out any indication of an eruption until we had crossed nearly three-fourths of the stream, which here is not far from a mile wide. Then our attention was attracted by an accumulation of scoriæ. Nearing this we were struck by a current of hot air, and, a little farther on, found ourselves on the brink of a deep gap in the lava about twenty feet wide, but narrowing and continuing northward. We walked round the southern end of the gap, and followed it up on the western or lee side. Before long we came to another enlargement of the fissure, like the former, emitting hot air charged with acid gases which drove us back. Still continuing our march on the west side of the fissure as close as the hot gases would allow, we came in sight of a pretty miniature cone, built up most regularly of loose scoriæ to the height of twelve feet, and located right over the fissure. It encloses a chimney crater of about twelve feet diameter, with perpendicular sides, the depth of which could not be ascertained. Hot gases issued in abundance. On account of the exhalation of the latter we were obliged to cross the chasm, on the bridge formed by the side of the cone, to the windward side, along which we followed up steadily.
>
> This crack or fissure tends south six degrees west to north six degrees east and is in the slope of the hill that forms the west boundary of the lava-stream. Its lava cover therefore is quite thin in many places, so that you can see how it sinks in the original rock of the hill. Its depth cannot be ascertained anywhere. More than four-fifths of the lava is on the eastern side, as it followed the declivity of the hill-slope to fill the trough of the valley, where it assumed a general downward course. It is from the entire length of this fissure that the lava has welled up simultaneously. The waves of lava for some distance from it are all parallel to its course, while in the middle of the stream they stand at a right angle to it. The edges are somewhat raised above the remainder of the stream, and scoriæ covers it in most parts, forming quite heavy layers where the stream has blowholes. Isolated flakes of brittle lava, resembling cow-dung, probably blown out at the end of the eruption, with fitful spouting of steam and gas, are seen all along its course. Nearing the upper end of the valley, where I expected to find the end of the fissure, I was surprised at the sudden appearance of a veritable cataract of lava coming down the precipitous side of the eastern hill, a height of at least three hundred feet. Having ascended it with considerable toil, I found myself again alongside the big crevasse, which in passing across the valley had deflected from its former course to a nearly N.E. direction, heading direct for the summit of Mauna Loa.
>
> From here onward, the incline increasing considerably, the lava commenced to be very rugged and broken. As here it had passed over and destroyed a dense forest, a number of grotesque shapes met the eye. Wherever the lava had met a tree of some size, it had surrounded it with a perfect mould which either still held the smouldering remains of the trunk, or exhibited hollow cylinders bearing on the inside the markings of the bark of the tree. The leaf stalk scars of fern-trees were almost perfect. A few of the moulds contained still entire trunks with the unconsumed branches. In the bifurcations of these, heavy masses of lava had accumulated, hanging down in wavy points

like so many stalactites. Wherever there was a fern stump standing upright, it bore a cap of lava; everything indicated that the liquid mass had been thrown upwards by the violent rush of steam and gas. As I said before, this part of the flow was lined by a dense forest. It soon became apparent that the sides of the forest closed in upon each other, and from an eminence alongside the fissure I could see that the lava-stream contracted at some distance beyond to the apex of an isoceles triangle. The crevasse which ran straight up to the apex, was continuous, wider than below, and emitted in great profusion sulphurous and other acid gases. Its borders, which were of the color of red brick, commenced to be covered with the efflorescence of salts and sulphur, and in places they assumed altogether the appearance of sulphur banks. The heat of the lava increased so as to be unbearable in some places. Ashes and scoriæ covered every hollow in the floor, and the edge of the woods for some distance.

Having arrived at the apex of the triangle, I found that the crevasse, over which the trees almost closed from both sides, still extended a few hundred yards higher up in the woods, as indicated by a continuous line of white and yellow smoke. The choking nature of the latter forbade my marching along the edge of the fissure, while the impenetrable thicket, with the ground thickly covered by ashes, proved another effectual bar to my further progress. In fact, while hurrying out of an overpowering cloud of the smoke, I got one leg caught in a lateral fissure hidden under the ashes, where it received such a lively impression of heat that I made quick time to retire from that neighborhood. Just then I heard a deep, hollow, rumbling, prolonged sound, while the air and earth remained perfectly still. Subsequently I learned that it had been caused by the rolling down of large masses of pumice stone from the hill to the lower lava stream, but at the time being fearful of another catastrophe, I hurried back as fast as circumstances would permit, and felt a great relief in rejoining my friends who had remained behind, at the lower part of the stream. From the height above the cataract I saw two other lines of smoke running through the woods, taking their origin from the valley below, indicating two other fissures. Thus it appears that at the head of the valley the main fissure divided itself into three parts: the first and largest, running northeast; the middle one almost due north, and the third about north-northwest. The two latter did not seem to have thrown off much lava, if any, for there appeared no gap in the woods along their courses.[83]

From a letter addressed to me under date of August 27, 1868, by the Rev. T. Coan, I extract the following important facts and accurate descriptions:

I left Hilo on the fourth of August, on a missionary tour through Puna and Kau, and was absent eighteen days. During this tour I made careful observations with measurements and notes, on the remarkable volcanic phenomena of the past five months. The action of tellurial forces on our little island shell has been marvellous. The subsidence along the coast of Puna, from the east cape at Kapoho to Apua on the western line, is four to seven feet, varying in different localities. The great sand beach at Kaimu has been forced back into the young and beautiful coco-palm grove, and also into the groves of pandanus, so that trees now stand eight feet deep in sand, and many stand in the water. The plain of Kalapana has sunk about six feet, and water four to five feet deep now covers some twenty acres of what was once dry land. The old stone church is buried nearly to the eaves in sand, and the tide rises and falls within it.

This plain of Kalapana was doubtless at some former time buried much deeper beneath the sea. A coral reef of several yards thickness stretches half across the valley, and formed a barrier against further encroachments of the sea. It was three or four feet above high water mark, and formed a convenient site for the village. The church that Mr. Coan mentions was on this coral mound towards the shore. As the wall of rock which bounds the plain on the southerly side shows clearly that some former subsidence resulted in a rupture of the crust forming the floor of the plain from this wall, it would have been well to note any change at this point. Mr. Coan observed none, and the loose rocks knocked down by the protracted earthquakes would perhaps obliterate any traces of so slight a dislocation as a fall of six feet would cause.[84]

---

[83] Honolulu, May 4, 1868.

At Kealakomo the salt-works are destroyed and the fountain on the shore sunk. Apua, the last village in Puna, was swept clear [by the tidal wave of April 2nd] and sunk. Its pretty sand beach and miniature bay rendering it a resort for fishermen, are no more; the sea stands some six feet deep where the houses once stood. The same is true of Keauhou, the first village in Kau, and an important pulu station; coconut trees stand seven feet in the water, and all the buildings were swept away by the tidal wave. Passing on to Punaluu, this wave rose twenty feet and swept all before it. The great sand barrier which protected the beautiful pond and the cold, limpid spring, was first swept into the sea and then brought back and deposited in the pond, filling it up and changing the shore line. I got the height of this wave by measurement on a palm tree, and also upon the surrounding ridge of scoriform lava, making the rise above common high water about twenty feet.

From Punaluu onward to Honuapo, all houses were swept away except two standing on high lava ridges. The road was strown with boulders and fragments of rocks, and in some places it has sunk, so that it is with great difficulty, and not without a guide, that the traveler threads his zigzag way along this coast for five miles. Not a house remains in the considerable village of Honuapo: the sea occupies the site of former dwellings. The wave here corresponded with that at Punaluu, as shown by measurements on coconut trees. There were points where the influx of the sea was greater than at other places, and this seems to have been caused by the approach of the wave from the southwest, or at an angle of 45° to the shore, and by striking headlands and projecting points causing the waters to heap up within the points of tangency, while the current swept on at a lower mark where the coast presented no lateral obstructions.[85]

In crossing over the great lava fields from Puna to Kau, I passed about nine miles to the south and leeward of Kilauea, the great volcano flanking us on the right. The country through which we passed was terribly rent by the earthquake of April 2nd, and in some places we were obliged to deflect widely from the old track to avoid fissures. For several miles the cracks were so numerous and so wide, that a stranger would be utterly unable to find his way through this mural network of fractures. Our guide zigzagged us everywhere, our animals often demurring, trembling, and refusing to go. The whole atmosphere was filled with sulphurous smoke, through which the sun shone with sanguine rays. After passing most of these fissures, I requested my guide to turn to the left and follow the line of fissure seaward, hoping to find the locality of a disputed eruption which it was affirmed by some and denied by others had taken place in that wide and wild field of ancient lavas. After an hour of hard search amidst hills and ridges of aa and fields of pahoehoe, we found a veritable eruption......The fused lavas had been thrown out of the fissures at five different points, on a line of less than a mile in length. The largest batch was one thousand feet long and six hundred feet wide, with an average depth of ten feet, and with a steaming and tumulated surface. This series of small eruptions is about eleven miles southwest of Kilauea, and it shows distinctly the subterranean path taken by the igneous flood which left that seething cauldron on the night after the rending earthquake of April 2nd. That shock doubtless opened a pathway for the struggling fires, and they went off in a southwestern course under the highlands of Kau, uniting with the subterranean fires of Mauna Loa, and finding a fuller vent at Kahuku on the seventh of April. This is the theory, and it is rendered probable by the great and constant trembling of the earth along that whole line, by subterranean noises heard by the people of Kapapala, Keaiwa, Waiohinu, and other places, and by the issuing of steam at several points from fissures along that line.

---

[84] In crossing this plain twenty-five years later I found my surmise correct and the former wall had been covered by the confused fragments.

[85] To the casual traveler no signs of this shore catastrophe remain. Wharves and villages replace those destroyed, and even a sugar-mill and its surrounding hamlet occupies one of the points where the ravages were greatest.

When it was found that Kilauea had discharged its contents, the first supposition was that the course of the eruption of 1840, or towards the southeast, had been followed, and this was strengthened by the report of fire seen at the bottom of some of the numerous pit craters on that line; but while it is possible that lava may have been injected in earthquake fissures opened in this direction even so far as the pit craters (see map, p. 51), the probable path was that indicated by Mr. Coan, which is apparently the same as that of the eruption 1823. When the Rev. William Ellis went over the ground the next year he found deep fissures extending in a southwest direction, some of them ten or twelve feet across, and emitting sulphurous vapors at a high temperature.[86] In one place where the chasm was about three feet wide, a large quantity of lava had been recently vomited. I do not agree with Mr. Coan that the lava from Kilauea and that from Mauna Loa effected a juncture before reaching the surface. It seems more probable that the former passed into the sea near Punaluu, as did that of 1823, not appearing above ground except at Kapapala. The fact that the openings on the side of Mauna Loa above Kahuku were much higher than those mentioned at Kapapala, seems to indicate conclusively that the lava of Kilauea did not flow out in the stream that deluged the height above Ka Lae. The lava of both these volcanic vents is so similar that nothing can be inferred from that of its individual source.

Landslide.—Between Kapapala and Keaiwa in Kau, I examined what has incorrectly been called the Mud Flow. I went entirely around it, and crossed it at its head and center, measuring its length and breadth which I found were severally three miles long and half a mile wide. The breadth at the head is about a mile, and the ground on the side-hill, where the cleavage took place, is now a bold precipice sixty feet high. Below this line of fracture the superstrata of the earth, consisting of soil, rocks, lavas, boulders, trees, roots, ferns and all tropical jungle, and water, slid and rolled down an incline of some 20°, until the immense masses came to the brow of a precipice near a thousand feet high, and here all plunged down an incline of 40° to 70° to the cultivated and inhabited plains below. The momentum acquired by this terrific slide was so great that the mass was forced over the plain, and even up an angle of 1° 30′, at the rate of more than a mile a minute. In its course it swept along enormous trees, and rocks from the size of a pebble to those weighing many tons. Immense blocks of lava, some fresh as of yesterday, and others in all stages of decomposition, were uncovered by the slide. The depth of the deposit on the grass plains may average six feet: in depressions at the foot of the precipice it may be thirty or even forty feet.[87]

Eruption in Kahuku.—From the land-slide I went on to the igneous eruption in western Kau. Rents, tiltings, and other disturbances of the strata were seen along the shore, while the wooded and grassy hills on the right were scalped, scarred, cracked and striated, some of the once green hills looked as if a gigantic cultivator had been driven down their sides, tearing off the sward and exposing the soil in wide parallel grooves, and leaving broad belts of vegetation resembling rows of sugar cane. In passing from Waiohinu to Kahuku, we started a little after sunrise and rode westward. About three miles from Waiohinu we crossed a lateral arm of the eruption, about one-sixteenth of a mile wide, and some two miles long, from where it left the parent stream. It was a high ridge of aa, say twenty-five feet deep, and running in a southeasterly direction. Crossing this and riding half a mile over verdant and beautiful fields, we come to another lateral outgush of similar character, and dimensions. Then came a third, which flowed some four miles and threatened to fill the harbor of Kaalualu. This was longer and broader than the other two, but of the same general character. After another half mile we crossed a fourth rugged stream of aa, and then moving southwest we rode rapidly over a fine surface of soil down a slope of about 3° to the ends of the two large parallel streams that entered the sea at Kailikii. Over all this wide field of pasturage, cinder and pumice had been scattered, and the grass had been consumed as by a prairie fire.

---

[86] Ellis's Polynesian Researches, London, 1859, vol. iv, p. 220. See also quotation on p. 39 of the present work.

[87] I have a map of the landslide constructed for me by the late Latimer Coan, son of Rev. T. Coan, but it seemed unnecessary to reproduce it here, the descriptions are so definite.

This portion of the eruption went into the sea about one mile northwest of Ka Lae, the south cape of the island. On the left flank of the stream is a high and very steep ridge (four hundred to five hundred feet high), extending from the cape up the southern slope of Mauna Loa. The outburst of April 7th commenced about ten miles from the sea by the opening of a horrid fissure in the forest on the upper side of this precipice. For about three miles the burning river flowed down partly above and partly below this precipice. The area above was rich and beautiful land for cultivation and pasturage; that below was simply pahoehoe. The four lateral streams before mentioned all ran off upon the beautiful highlands, covering several thousand acres, but without reaching the sea. Some three miles from the head the main stream went altogether over the precipice, and pursued its rapid course over the pahoehoe some seven miles to the sea which it reached in two hours. There it formed, as is usual when lava streams enter the sea, two cones of lava sand, or lava shivered into millions of particles by coming in contact with water while in an intensely heated state. There is no island there and there is nothing but what is common under similar circumstances. This stream is about half a mile wide, and it entered the sea some three-fourths of a mile from the high pali before spoken of. After running a day or two, in this channel, partial obstructions occurred, by cooling masses, when the shell of the stream was tapped some five miles from the sea, and a torrent of white-hot lava pushed out on the east side, running off to the great precipice and following its base in a breadth of half a mile down to the sea, and thus forming an island five miles long and a quarter of a mile wide, surrounded on three sides by fire. Three houses stand unscathed on this islet, and about thirty head of cattle were inclosed by the igneous flood.

The route taken by this lava flow was substantially that of a stream of unknown date, but whose smooth surface of hard pahoehoe looks fresh and undecomposed. Where this ancient stream originated is not known, for no one has ever taken the trouble to trace up the various flows that radiate like the spokes of a wheel from the cone of Mauna Loa.[88] The pali referred to was probably formed by the subsidence of the ground over which the successive streams of lava have flowed, and it forms the boundary of a fine pasture land, which appears to have been exempt from these lava inundations for many ages; the outcropping ledges of lava are weathered and lichen-covered until they resemble the gneiss and granite rocks of New England, at least from a distance.

---

[88] It will be seen from the map of this island that the government survey has done much in tracing the flows of known date, but much remains to be done, although it is probably impossible to fully trace other than the superficial flows.

The flow of 1840 which reached the sea at Nanawale, formed conical hills which lasted many years although composed of the loose gravelly rapilli resulting from the sudden shivering of the lava, and the same form of cinder piles is seen at the junction of lava and sea-water in this flow of 1868. It is not universally the case, however, that lava is broken up in this way when passing into the sea. Sometimes the heat has been so intense as to induce the spheroidal state preventing the actual contact of the water, and the melted rock has run on under the water, forming submarine ledges of pahoehoe.

From the shore we rode up on the elevated plateau with the two parallel streams of cooled lava on our left, some five hundred feet below, with nothing to obstruct a full bird's eye view of the scene. At length we came to the great trunk at Kahuku, from which all the lateral branches had been sent off. At our right on one of these branches were the ruins of the large stone church of Kahuku. The great earthquake had shaken down the walls, and the roof was lowered and standing over the ruins, around which the sea of molten lava had flowed, leaving them upon a small island unconsumed and uncovered. One-eighth of a mile above this, and on the same stream, we saw three small thatched houses, where four natives had been surrounded by the burning sea and confined for ten days in this fiery prison. The whole inclosed island contained about an acre, and before the people were aware of it, no avenue of escape was left. The hot clinkers came rolling along in a great stream within twenty-five feet of one of the houses, and cooled in a ridge as high as the top of the house. We climbed over this rough mass and visited the people who still live in this awful but now romantic inclosure. They seemed cheerful and were right glad to see us. On inquiring how they felt and how they spent their time during those days of fiery trial, they replied that in expectation of certain death they were calm and resigned, looking up to God and spending most of their time in prayer.

Passing up the main stream, we came to the place where Captain Brown's houses once stood; just in the rear of this was an awful vent from which fiery jets were thrown hundreds of feet high, with fearful hissings and belchings. Beyond this we saw numbers of green islets, of two to five acres in extent, formed by the surging sea of fire as it seethed and boiled and swept around these reserved places. On some of these islands cattle were feeding, and twenty head were taken from one islet of less than two acres, after the lavas were partly cooled. They were terribly heated and frantic, and some of them died. Still pursuing our course upward, we veered to the right, and once more took the soil on the uplands which bordered the stream. Here the great trunk of the stream was in its full breadth and I hired two men to measure across, while we rode through a charred forest and deep cinders more than one hundred feet above the shining lava fields which lay on our left. At length we descended again to the stream of fresh and warm pahoehoe, and rode nearly a mile upon its crackling surface. We soon came to a region of fissures and blow-holes, and where the evidences of Plutonic fury were unmistakable. From these infernal orifices amazing jets had been thrown hundreds of feet heavenwards, forming ridges, hills and jagged cones of every contour, and leaving the products of raging seas and rivers of fire, such as must have been appalling to near witnesses of these fiery dynamics. Here we left our horses, and with great effort struggled over the sharp and confused masses which were heaped wildly around. Climbing a rough hillside some two hundred feet high, and on an angle of forty-five degrees, we came upon the great head fissure from which the first lavas were disgorged. We followed this to the terminal point in the woods, over ridges and heaps of cinder, pumice and scoria. From this high terrace we could overlook the stream below for about three miles. The great vent or fissure extended longitudinally and in an irregular line for two and a half miles or more, and at many points along this line the steam and smoke were still rising with no little heat. No fire was, however, seen; it all disappeared in less than four days after the commencement of the eruption. The fissure opened from two to twenty feet wide, and there are places where it is interrupted or so narrow that it can be crossed. [494]

Near the head of this fissure a small quantity of sulphur is found, as also alum, gypsum, Glauber's and other salts; none of these are abundant, and the products of this eruption are identical with those of all former eruptions on this island. Returning to the point whence I had sent the men to line across the stream, I regretted to find that they had measured until they came to the great fissure, and seeing no way of crossing it, had returned. They had measured half a mile, and thought they were half way across, but from sight I judged they were only one-third across, giving a mile and a half as the estimated width at this point, which was about the widest place of the undivided or trunk stream. I would say that the average width of the flow by uniting all the branches would be one and a half miles, the length ten miles, and the average depth fifteen feet. Where it entered deep basins and gorges it is fifty to a hundred feet deep, but where it spread over grass fields and unbroken surfaces, we find it from two to fifteen feet deep. The course of the main stream, the one that entered the sea, is due south. The flow upon the surface was short and energetic, some say three and some five days,—we give it as four days. The scene was brilliant and awe-inspiring; obstructions along the line of flow often opened vents through which fiery jets were thrown up to the height of five hundred to seven hundred feet, with amazing brilliancy and a force which made the earth tremble. All the southern coast of Hawaii was illuminated with the dazzling glare; but the amount of matter discharged is small compared with the eruption of 1855.

Kilauea.—In going to Kau my route was along the shore road through Puna; my return was via Kilauea. At this place I spent a day and a night, and examined the changes. Previous to the great earthquake, the fiery abysses of Kilauea had been in a raging condition as if seeking vent. The molten sea had broken up vertically in the bottom of Little Kilauea, and had left a burning stratum upon the old deposits of 1832. The terrible rendings of April 2nd tore up the earth, opened great fissures everywhere around Kilauea, sent down thundering avalanches of rocks from the high surrounding walls, and probably opened a subterranean passage for the igneous flood to the southwest. That night Pele decamped in this underground passage, and the central area of the great crater subsided about three hundred feet, leaving or rather forming a new Black Ledge of unequal width, all around the crater. In some parts the central depression left the ledge a perpendicular or beetling wall with a serrated line, but in most parts the centre sagged away gently forming a large concave basin with an angle of 20° to 70°. The surface of this concave was once the crowning or convex central portion of the crater, where ferns and ohelos have been growing for nearly twenty years. This superincumbent plateau has been depressed so quietly that the surface is very little disturbed, and the ferns and bushes are still growing in the basin three hundred feet below their position on the first of April. Some parts, however, of this great area have been covered with fresh lava, and some ferns have been killed by heat and gases.

From the black ledge I passed down and across this depression (about a mile), and then up the ascent on the other side for half a mile to the rim of Halemaumau. This is all changed; it has gone down some five hundred feet below the highest point on the black ledge, and about two hundred feet below the depression in the basin before mentioned. The walls have fallen on all sides, and the pit resembles a vast funnel, half a mile in diameter at the top and about fifteen hundred feet across the bottom. There are two places where visitors can descend into this great pit, with some difficulty and risk. Much of the time this pit is filled with smoke and sulphurous gases, with little visible fire; occasionally explosions, detonations, and fiery demonstrations occur in this awful pit.

On the fourteenth, fifteenth and sixteenth of this month (August), the sea was agitated around our entire group, rising and falling from two to four feet above and below the ordinary marks, once in ten, fifteen and twenty-five minutes; the accounts of rise and time vary as noted in different places by different observers, and I give the range.

The sea-waves of which Mr. Coan speaks were doubtless caused by the terrible earthquake which on the thirteenth of August shook the whole western coast of South

America, and drove an oceanic wave to the shores of New Zealand and these islands. But although this was decidedly a foreign volcanic or seismic demonstration, the vibrations of the land of Hawaii have not ceased, and it is not at all improbable that the reservoirs of lava are emptying themselves beneath the sea; certainly the lava is in motion. The destruction of life and property on Hawaii was comparatively small, owing to the nature of the district affected. The losses in Kau were as follows:

Houses destroyed by land-slide.......	10	Deaths, 31
Houses destroyed by sea-wave	108	Deaths, 46
Houses destroyed by earthquake	46	Deaths, 0
Houses destroyed by lava-stream	37	Deaths, 0
Totals	201	77

One life was lost in Puna by the sea-wave, and one in Hilo by a falling cliff. A shock of no greater violence in the city of Boston would probably have killed fifty thousand people, and laid most of the city in ruins.

The data for determining the direction and force of the vibrations are quite different from those used by Mallet in his remarkable investigation of the Calabrian earthquake of 1857. The houses are mostly of wood and grass, and stone walls are built of angular blocks of lava, often without any cement; a brick wall or wall of hewn stone, is not to be found in Kau. On the other hand the rocks which form the upper crust are of uniform composition, the direction of the strata is well known, and there are no strata of sedimentary rock to mislead by reflection of earth waves. On the whole, Hawaii offers many advantages for the study of seismic as well as volcanic phenomena. (Published March, 1869.)

Forty years have passed and I have little to add to the careful record of these observers, nearly all of whom have passed from earth. Neither have I much to correct in my own observations on the record. Many times I have passed through the country so terribly shaken, and every time I have cause to wonder, not at the rapidity of the destructive force of the earthquakes and lava streams, but at the rapid healing in the skin of Mother Earth in this climate. The great cones, the wide chasms are there, but how changed! Quiet and peaceful, they add so much to the grandeur if not to the beauty of the scene. The avalanche of earth, stone and water that was so much more fatal to life than the volcanic outbreak, has now disappeared beneath vegetation, and while I could trace it easily in 1880, when I passed that way a few months ago I could not point it out to my companions.

The seismic studies are not much advanced here, although the island of Oahu boasts a seismometer. No scientific body has built an observatory on the brink of Kilauea, and no competent observer has established himself in our midst.[89]

---

[89] Since the above was written two of the Professors of the Massachusetts Institute of Technology, Messrs. Jaggar and Daly have visited Kilauea with a view to determine the desirability of establishing an observatory there under the control of that institution.

In July of the next year Mr. Coan was able to descend into the pit of Hale-
maumau and measure across the cooled surface which was then four hundred feet
below the rim. Its diameter was "five-sixths of a mile," and the Halemaumau must
have been quiet, but by no means "dead," for in that condition volumes of smoke are
generally emitted from the pit (see Fig. 26), and now he could see lava in
1869 ebullition far below the surface, perhaps a hundred feet below, through some
of the many cracks in the hardened crust.[90] In 1871 Halemaumau was full
1872 to overflowing and the lava had run two miles northward over the crater
floor; the central depression was filled some fifty feet from the same source.
In August of the same year the pit was emptied of lava but still very hot and full
of dense vapors, but within a year (August, 1872) it was again overflowing into the
great central depression.

March 1, 1872. Clarence King and Arnold Hague.—King reports: "A fluid stream of basalt overflowed from the molten lake at the south end of the crater and flowed northward along the level basaltic floor of the pit. Numerous little branchlets spurted from the sides of the flow......and then congealed. I repeatedly broke these small branch streams and examined their section. In every case the bottom of the flow was thickly crowded with triclinic feldspars and augites; while the whole upper flow was nearly pure isotropic and acid glass."

October 21, 1872. D. H. Hitchcock.—"Halemaumau is like what it was from 1845 to 1868, an immense dome six hundred feet higher than the centre of the pit, equalling in altitude the bordering black ledges. On its summit are two lakes from which lava streams down in various directions. Nothing is left of the high banks surrounding the old south lake."

On March 3, 1873, Halemaumau was reported occupied by two lakes nearly
circular.[91] But in January, 1874, the surface of the great lake was thirty-five to forty
feet below the rim and the two parts had become oblong, according to a visitor.[92] In
June a more careful observer was at the crater, Mr. J. M. Lydgate, who
1873 made a map of the place in which the pools were again distinctly circular as
is shown in the reproduction of Mr. Lydgate's map now among the archives
of the Government Survey (Fig. 70). The central depression of 1868 is still distinct,
although partially filled.

The Volcano House record, while containing much trash, certainly has also on its pages much that should be preserved; much that is not elsewhere recorded.

---

[90] American Journal, 1879, ii, 454. Letter of August 30, 1871.

[91] Chas. Nordhoff: Northern California, Oregon and the Sandwich Islands.

[92] Miss I. L. Bird: The Hawaiian Archipelago, 55, 253.

I have endeavored to cull what I believe to be authentic. The period we are now considering is covered as follows (I have quoted the record as written; not merely as I think it should have been written):

January 7, 1873. Between 11 and 12 o'clock last night Mokuaweoweo started active again. The wind has been from the southward, and the whole day a dense body of smoke has been passing over Kilauea and across Puna off to sea. Weather hazy and top of the mountain seldom visible. Kilauea quite active, but no lava flowing.

January 31, 1873. Miss Isabella L. Bird.—There was considerable activity, eleven fountains of fire and waves of fire perpetually breaking into fiery spray.

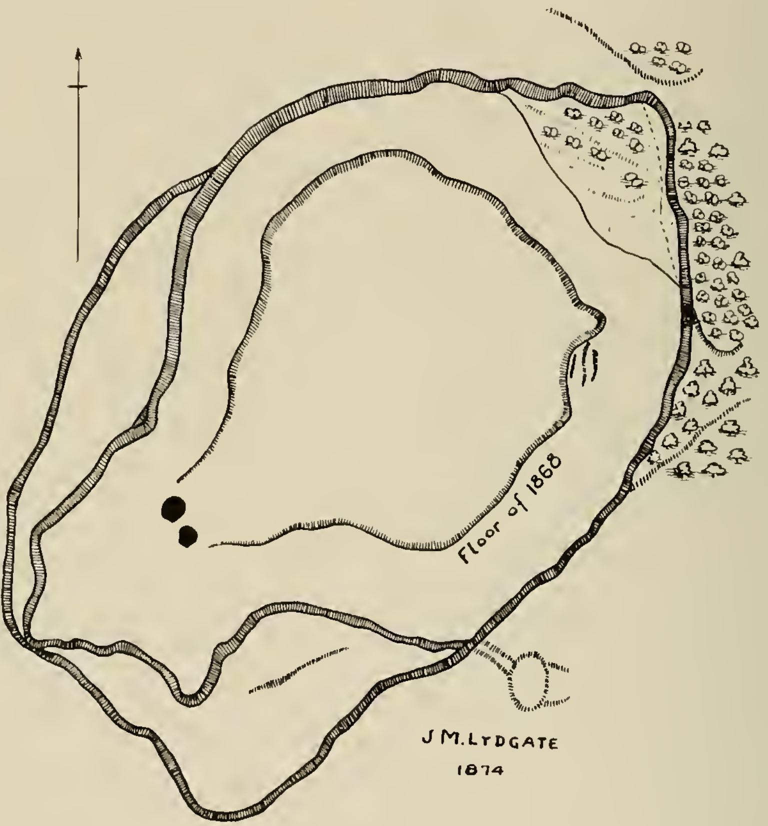


FIG. 70. SURVEY OF KILAUEA BY J. M. LYDGATE.

March 2, 1873. C. H. Williams.—The lake is at present divided into about two equal parts by a wall of lava. [Plate XLIV, lower view.]

March 13, 1873. J. N. Gilman.—The south lake is divided by a partition which forms two lakes.

March 22, 1873. Godfrey Brown.—South lake was very active, the jets of lava reaching to about fifty feet of the top of the bank.

June 5, 1873. W. L. Green. —The surface of the molten lake appearing to be fifty or sixty feet below the edge.... The level of the molten lava in the lake is some two or three hundred feet above the general level of the depression (a mile or so long), over which you walk to the lake. Mauna Loa is now active.

July 2, 1873. S. W. Pogue. —Very little action.

July 5, 1873. Luther Severance.—Crater active; lakes full to the brim. [See Fig. 71, which seems to represent this phase of Halemaumau (South Lake). Unfortunately the present owner of the photographic negative cannot assure me of its date.]

July 8, 1873. G. Jones.—At 9 A.M. the lava with which the south lake has been filled for some time broke through on the eastern slope facing the Volcano House, and has been running towards and into the basin [central depression of 1868]. On the 12th the south lake was very active and still full, although the new flow of over half a mile in width still continued. The crater on the summit [Mokuaweoweo] was also active.

July 28, 1873. H. Birgham found both lakes and the cones tolerably active, and saw the brook of lava flowing down the side of the south lake.

August 11, 1873. Dr. O. B. Adams.—The outflow from the south lake still flows and is visible through a large crack. It appears to be about twenty feet wide and flows like a mountain torrent.

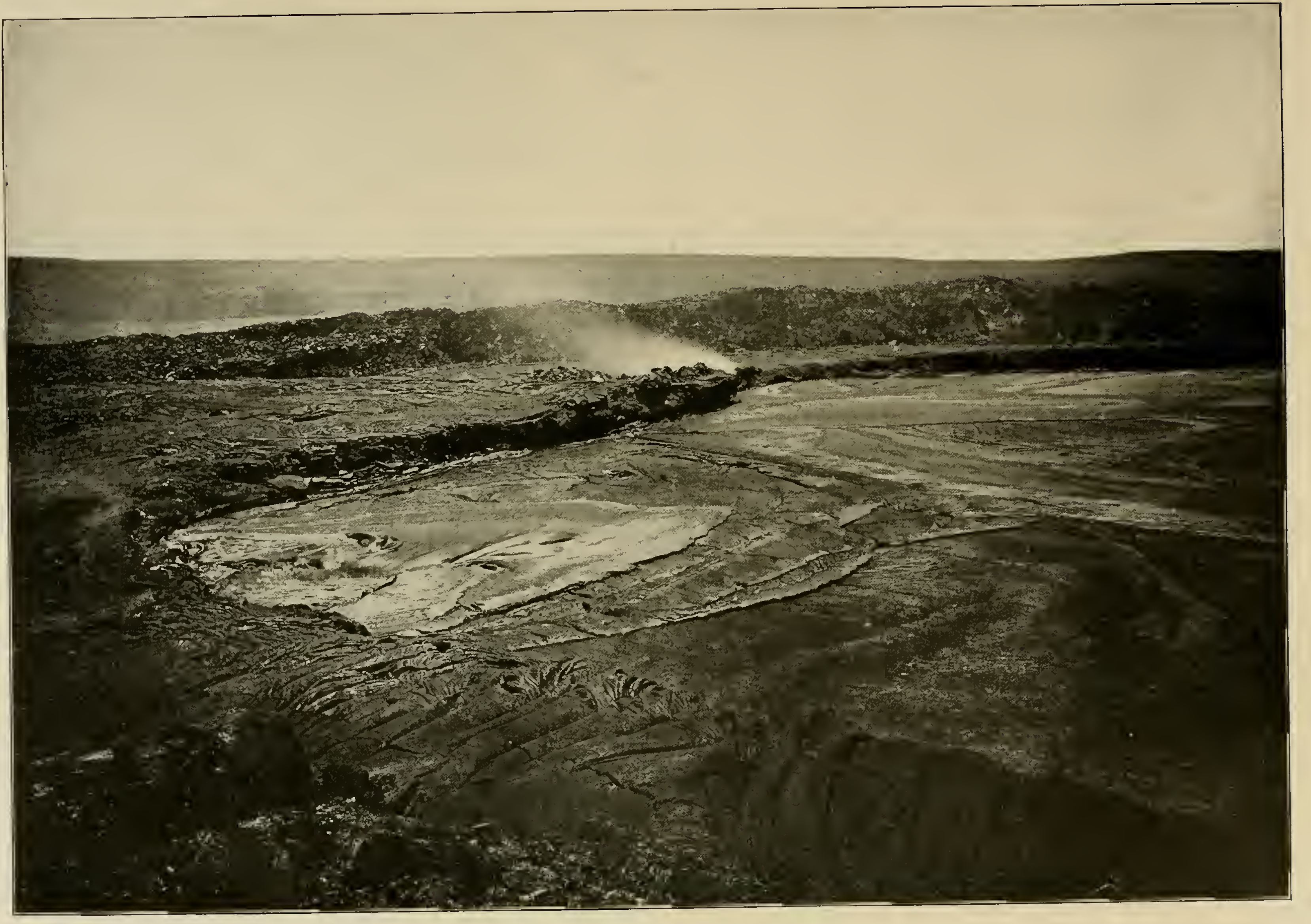


FIG. 71. CRATER OF KILAUEA.

August 29, 1873. Luther Severance.—Crater very active.

September 22, 1873. W. W. Hall.—I have just returned from a very interesting trip to the crater of Mokuaweoweo on Mauna Loa. Started from Kapapala with my guide John B. Kitu, a half-caste, at about 10 o'clock on the 18th, and stayed at Ainapo, the upper ranch, until half-past one. From there a man with pack mule and tent with food and blankets accompanied us and we all kept on our way up through the koa woods until four o'clock when we reached the usual camping ground. As it was so early, and as I was anxious to get as far as possible on the first day, we pressed on for three miles farther up the mountain where we found a very good camping ground where we pitched our tent and made a large fire, and spent a comfortable night. I had intended to start by five in the morning, but in the night a horse and a mule got away and went down the mountain. John started at three in the dark for them and reached camp again at six o'clock. We left "Hall's camp" at 6:30, and after passing or climbing over the most awful road I ever saw for four hours, we reached the crater at 10:30 o'clock. From the place where we left our horses we went along the bank towards the north....We went to the northeast point, and looking down the precipice, say about eight hundred feet, over the shelving mass of loose rocks and debris, I thought we might possibly venture to go down. I asked John if he would be willing to go with me, and he said "yes." So we started down, crawling carefully over the loose boulders, and letting ourselves down over huge rocks, until after half an hour's awful labor we reached the bottom.... which is now entirely covered with the flow of last year. From where we stood the awful walls of rock arose on every side, and it looked as though no human being could ever ascend from that vast depth. We had not time to go to the active south lake where the molten lava was heaving and surging with loud reports and hissing noises, so we took a turn over a third of the field of burning-hot pahoehoe and returned to the point where we entered. There are many blowholes in this field, and from some of them I collected specimens of lava too hot to be held in the naked hand. At night fires can be seen in these holes, and at all times the hot steam and gases rising with a hissing sound. The heat of the black pahoehoe was so great as to blister my feet through a thick pair of boots. We returned by the same way by which we had descended, and when we were again on the bank I felt that God had indeed protected us in a most singular way from every harm, and thanked Him for His goodness......It was a most fortunate thing for me that I had no bad feelings whatever, and could make as much exertion there as down here. Had it been otherwise I should never have attempted such a descent......About a mile from where our horses were we came across stone walls that must have been built for the sides of a house or camp. I found an iron eye-bolt and a piece of soft pine, both of which must have been there thirty years. I think this was Wilkes' camp of 1841, and I brought these away as relics. The crack containing water and ice seems to continue nearly round to the point where we descended,

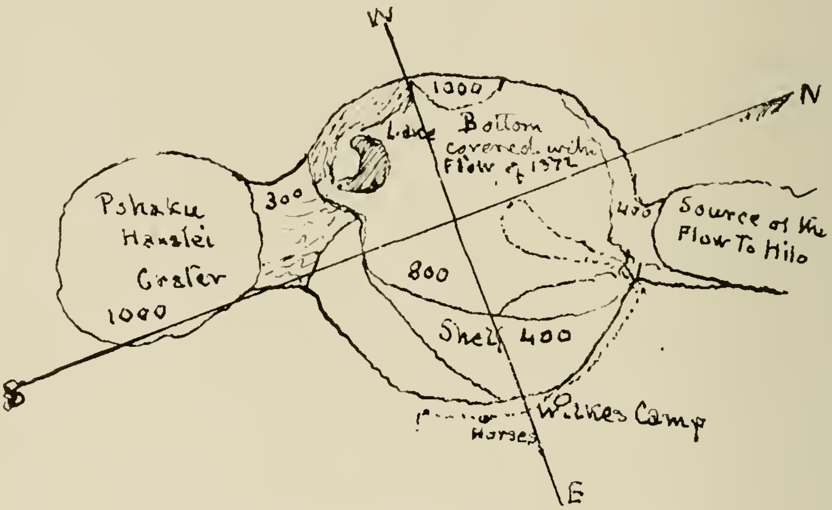


FIG. 72. W. W. HALL'S SKETCH PLAN OF MOKUAWEOWEO.

and in some places the openings are large enough to bathe in. We reached the horses, ate some lunch, and started down at 2 P.M., well paid for our great exertion.

September 27, 1873. T. Spencer.—Crater active, flowing all night toward the Volcano House.

January 17, 1874. J. E. Chamberlain.—Visited the crater fourteen years ago. The crater has filled up one-half. The two craters, 1859 and 1874, are almost totally unlike.

March 24, 1874. L. M. C.—The south lake has been gradually filling up until last night, when it overflowed. At eight o'clock the whole of the edge of the lake facing this house was alight with the flowing lava. A sudden change in the weather has accompanied this outbreak—cold wind without rain; thermometer 42°.

June 9, 1874. Frank Thompson.—The lava has been flowing from the open lake all day.

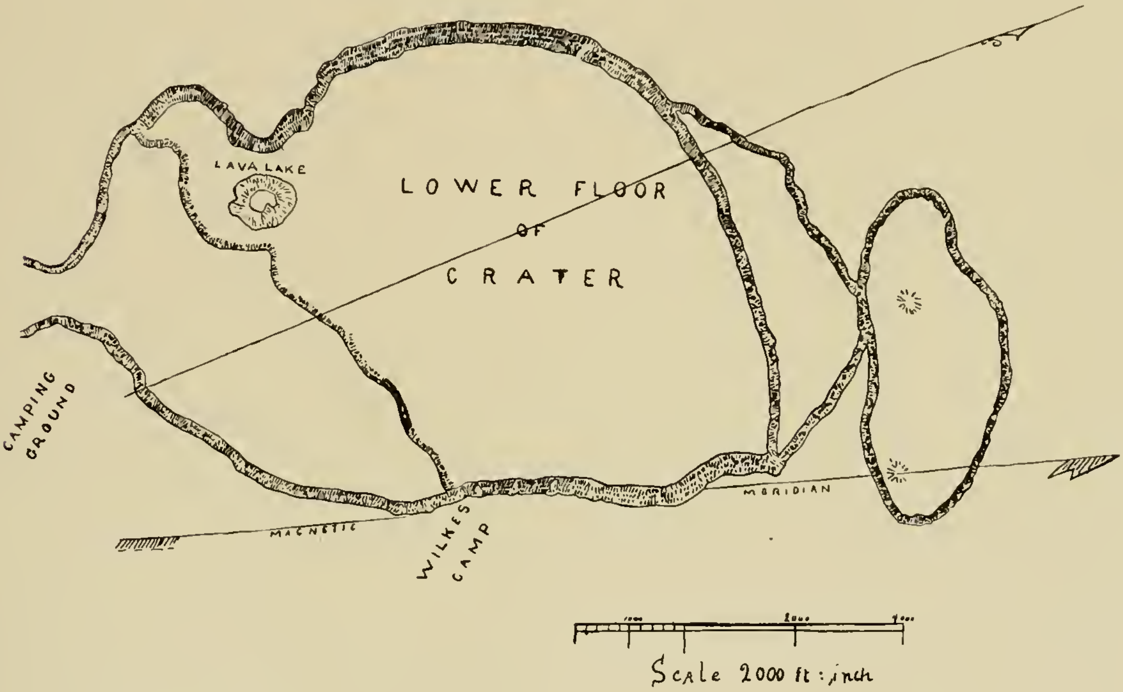


FIG. 73. SURVEY OF MOKUAWEOWEO BY J. M. LYDGATE.

June 24, 1874. John M. Lydgate.—The plan of the crater of Mokuaweoweo [Fig. 73] is from actual survey by triangulation. A base of 1876 feet was measured on the eastern side and from this, using a seven inch Queen transit, some twenty points were fixed indicative of the shape, topography, etc., of the crater. Its greatest length including the basin at the north end is 17,000 feet, or about 3.2 miles; excluding this it is 15,000 feet; its greatest breadth is 8600 feet or about 1.7 miles; its greatest depth 1050 feet. The floor, however, is continually rising owing to repeated overflows, and the lake is about 500 feet in diameter, and at the time of our visit was quite active, more so than I have ever seen Kilauea.

July 8, 1874. D. H. Hitchcock.—Volcano is very active. Crater filling up with new lava, but evidently sinking more and more as a whole. Halemaumau half the height of the lower or southern bank. Mokuaweoweo brilliant last evening.

July 10, 1874. G.[Gilman]—At 7.30 this evening, two sharp, quick shocks of earthquake were felt here,—an interval of about three minutes between them. The new flow begun last night seems to be gaining, a large portion of the central basin being alight with the flowing lava.

August 29, 1874. F. A. Schaefer.—Although at my previous visits ('61, '64, '66, '67, '74) I have seen more lakes in Kilauea in action, I have never seen any one lake in a greater state of commotion than this time. We found the south lake divided into two lakes of similar size by a bank about forty feet high, and the approach to either of them rather more difficult than in years past, on account of recent overflows of lava. Approaching the left-hand lake we had to pass through a great deal of sulphuric smoke which necessarily shortened our stay there, and prevented us from going as near to the brink of the lake as we would have wished, but still allowed an impressive glance at the surging and spouting liquid fire. The right-hand lake seen from a bank eighty feet high presented a magnificent spectacle. The bed of the lake was in constant commotion. Along its banks the waves of liquid fire dashed into spray like the waves of the ocean on the rockbound coast, and at times the molten lava was thrown high into the air······Returning we visited several openings which afforded us a view into a living stream of lava flowing from the south lake in an easterly direction, with a rapidity difficult to estimate. A river of liquid fire rushing along with extreme rapidity and with the characteristics of a mountain stream losing itself in the lower bed of the crater······Thermometer 54°–68°; once it went to 51°.

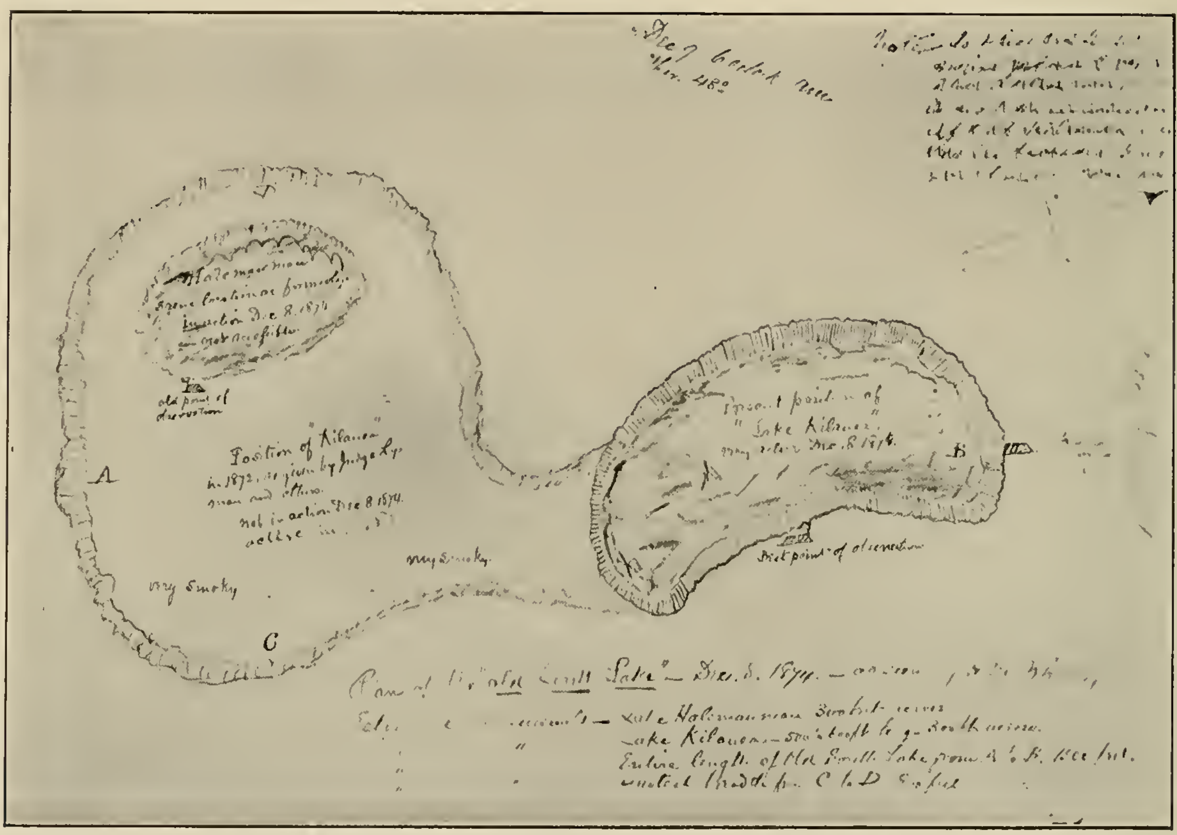

D
A
C
B
old point of observation
Position of "Kilauea" in 1872, as given by Judge Lyman and others. not in action Dec 8 1874.
very smoky
very smoky
Present position of "Lake Kilauea" very active Dec. 8 1874.
first point of observation
Plan of the "old South Lake" — Dec. 8. 1874.

FIG. 74. SKETCH OF ACTION IN KILAUEA DECEMBER 8, 1874.

September 9, 1874. B. F. Dillingham.—Have to report the crater of Mokuaweoweo in the same condition topographically as reported by last party and illustrated by J. M. Lydgate······The burning lake itself was less active than reported by the last party, still the action was very satisfactory at both ends of the lake, that nearest the camp the most active, throwing up jets varying in size and height, occasionally throwing up some hundred feet or more, the color of the lava appeared to us very peculiar being a bright vermilion and sometimes blood-red.

September 20, 1874. C. E. Stackpole.—At one o'clock last night the lava broke through the crust in the eastern edge of the basin, near the trail, and flowed rapidly westward. The liquid lava spread over several acres of the basin in a few moments, flowing very rapidly. The outbreak was accompanied by a dull, sullen, roaring sound, apparently far below the surface. In spite of a heavy fog, the fire lighted up the crater and surroundings; every part of this house was filled with the glare, making it as light as day. By three o'clock the lava had cooled and the flow had ceased. A steady rain all night, no wind, thermometer 64°.

October 21, 1874. Rev. Titus Coan.—Found the crater quite active.

December 8, 1874, H. M. Whitney.—Found the crater in about the same state of activity as at former visits; but the area of the lakes has increased and changed very much since my last previous visit in 1864. Then there was but one lake, now there are two, both much larger than Halemaumau formerly was...... Halemaumau is located in the southern part and not easily accessible. The new and larger lake at the right is called Kilauea and our party stood within six feet of the edge of the bank on the windward side from which position a fine view was obtained of the whole of this boiling cauldron, and at a hundred feet above the liquid mass. [See Fig. 74.]

December 29, 1874. F. S. Lyman and W. H. Reed.—The two lakes, Kilauea and Halemaumau are both very active, and the large flow of lava from Halemaumau into the basin of the crater, which we were told occurred on the 27th inst., is still aglow, occasionally bursting forth on the surface and at the lower edge. The roar from the lakes was very loud at times during the night.

While Kilauea went on in much her usual way during the ten years from 1864 to 1874, Mauna Loa seemed to be adopting the chronic state of activity long a characteristic of her lower neighbor. In 1868 the activity began as we have seen, and while the size of the rent (some three miles long), allowed the surplus lava to escape rapidly, that outflow seems to have for a time closed that escape valve, and the activities were transferred to the summit crater, Mokuaweoweo. In December, 1869, visitors to the summit found much steam but no visible fires. During the first few weeks in 1870 steam and smoke arose from the crater in such quantities as to to be visible at Hilo. This did not last long and later in the year Mr. Luther Severance found Mokuaweoweo quiet. On the tenth of August, 1872, Mr. Coan saw from Hilo[93] "a lofty pillar of light two thousand feet high". No fire was seen from below, only its reflection on the column of vapors. It should be borne in mind that when "a bright light like a star" is seen from the coast level at Hilo it means, if from the summit crater, a fountain playing at least twelve hundred feet high, so flat is the summit plain of Loa in the midst of which the crater is situated. All through August and into September the activity of Mokuaweoweo continued. On August 23d a tidal wave was observed at Hilo in calm weather and without earthquakes. The first wave rose four feet, then at an interval of six minutes a second three feet high, and so diminishing for a dozen waves. There is no evidence of connection with the island volcanoes. Certainly the summit crater of Loa was not emptied as Mr. J. M. Lydgate found a fountain still playing the latter part of August, and Mr. H. M. Whitney, also a careful and experienced observer, found in September a fountain of lava seventy-five feet in diameter and five hundred feet high in the southwest corner of the crater; the pool around it covered about a third of the bottom, and certainly did not indicate any tapping of the supply at any lower or submarine level. In January, 1873, the action as seen from Hilo was "marvellously brilliant,"[94] the illuminated vapors rising thousands of feet. The herdsmen at Ainapo reported the mountain as constantly quivering like a boiling pot. The light was suddenly quenched, but in April the activity was fully renewed. On the sixth of June Mr. W. L. Green was at the summit and from him we learn that—

---

[93] American Journal, 1872, iv, 406; 1873, v, 476.

> The fountain generally played to a height of from three hundred to four hundred feet, as estimated from the known depth of the crater, although some spires or shoots would now and then rise to a greater altitude. The form of the fountain would constantly vary, sometimes being in the shape of a low rounded dome, then perhaps forming a sort of spire in centre, with a fountain in the form of a wheat sheaf on each side. Sometimes it would look like one great wheat sheaf. On this day the visible vapors or gases connected with this fountain were quite insignificant; by daylight we could see none, but at night-time the bright reflection from the molten lava made visible a light blue haze which quietly left it. Some observers of this same fountain, a few months before, and when it was much higher, reported that they heard the sound of escaping steam or gases. Some of them even believed that they heard the roar of escaping steam or vapors, some time before they arrived at the edge of the crater. We enquired very particularly, however, from one of the most intelligent of the party, and he assured us that there was no proof that the noise they heard was that of escaping steam or gases. I have sketches drawn by two of the party, which show little or no steam or gases. There were two noises, however, which were very easily distinguishable: one was the dull roar of the fall of this fountain of heavy liquid, and the other was the metallic clink of the fall of the solidified lavas which were constantly taken up by the fountain and thrown onto the solid rocks at a little distance from it. Indeed, these solid pieces and separate portions of the molten lava, which cooled in the air, formed a light falling veil over the dazzling lava fountain, and as it fell close round the sides, it formed a black level scum which floated on the lava lake, out of which the fountain rose. Whenever a more than usually solid mass of lava fell within the area of this lake, it seemed to force itself through the black, floating scoriaceous mass and make a golden splash of the white-hot lava beneath it. From different parts of the crater, and away from the fountain, white fumes arose like those which often appear in Kilauea crater.
>
> This night and for two nights previously, there was so little cloud, or condensed vapor above the edge of the crater, that it was not sufficient to reflect the light of the great molten fountain below. For weeks previously we had seen this reflected light, which indeed, was the only possible means by which a light in the bottom of the crater can be made visible to an eye situated outside of it, but below the level of its edge. The night before we left Kilauea, however, the light on the top of Mauna Loa was not to be seen, although the night was clear, and it was only when we got close to the crater, that a light smoke could be seen drifting away from it, whilst the great fountain of molten rock was playing below.
>
> There was indeed, nothing about this fountain that gave the impression of its having been produced by steam, incandescent or otherwise, or elastic vapors of any kind, but everything seemed

---

[94] Coan, American Journal, 1873, v, 476; 1874, vii, 516; 1877, xiv, 68.

to favor the idea of its being a simple hydrostatic effect, and as though a great artesian bore had been made to a stratum of molten rock, which had only been awaiting an opportunity to overflow.[95]

Miss Bird, who accompanied Mr. Green in this ascent, writes of it in her usual fluent style, and Dana is inclined to quote her as authority; but from a knowledge of her inaccurate and slipshod relations of other doings on these islands, I must look with suspicion on her testimony, and this is not needed, as Mr. Green was with her. We have seen in the Volcano House records of Messrs. Adams and the brothers Hitchcock that the action continued for eighteen months, most of the time with force enough to sustain jets of lava. Mr. Coan remarks that there were but few earthquakes during this period, and these of no importance.

In January of 1875 Mr. W. L. Green reports action in Mokuaweoweo lasting several weeks, and on August 11th Mr. Coan reports:[96] "The summit crater was again in brilliant action. The action continued, as appeared in the view from Hilo, for one week, and without any observed evidence of an eruption." In the Narrative of the Voyage of the Challenger[97] it is stated that parties from the vessel during the stay at Hilo, visited Kilauea, and "during the ascent a globular cloud was seen hanging in the air in the distance, which, as the guide explained, hung over the summit of Mauna Loa itself....As night fell this cloud perpetually reformed by condensation, and was lighted up by a brilliant orange glow reflected from the molten lava in the great terminal crater, and the general effect was just as if a fire were raging in the forest in the distance."

February 13, 1876, Mr. Coan reports a brilliant but short eruption on the summit, but no other outbreak noted.[98] On February 14, 1877, occurred another short but brilliant eruption from the summit. All the afternoon the mountain top had been covered with cloud or smoke as some considered it, but at half-past nine in the evening the curtain rolled away, showing a bright red reflection on the dark cloud banks
1877 above. As seen from Hilo by Mr. Coan, "the display of light was most glorious," columns of what Dana claims were illuminated steam, rose "with fearful speed to a height of fourteen to seventeen thousand feet, and then spread out into a vast fiery cloud, looking at night as if the heavens were on fire."[99] From Waimea Mr. Curtis J. Lyons of the Government Survey writes that the smoke masses were

---

[95] Vestiges of the Molten Globe, ii, 166. On page 168 of the same work he remarks: "With regard to incandescent steam, which Captain Dutton suggests as possibly representing to the eye a portion of these fountains, we may say, that we have never seen, on Hawaii, at any of the eruptions of molten lava, anything like incandescent steam. The *illuminated* smoke, gases, or vapors, which reflected the white-hot lava below them, we saw in abundance at the crater of 1859, and they are quite common at Kilauea and elsewhere; but incandescent steam we have never recognized at any of them." Captain Dutton had never, I believe, seen a lava fountain of any size, and found it hard to believe in their entire solidity.

[96] American Journal, 1877, xiv, 68.

[97] Vol. i, pt. 2, p. 766. The ship anchored in Hilo Bay August 14, and left on the 19th.

[98] American Journal, 1877, xiv, 68.

[99] American Journal, 1877, xiv, 68. Letter of March 17, 1877.

ejected to a height of not less than sixteen thousand feet above the top of the mountain, where they hung forming a dense stratum of smoke. The velocity with which they ascended was such that the first five thousand feet were passed inside of a minute.[100] From the deck of the "Kilauea" at anchor off Kawaihae, "five distinct columns of fire could be seen belching forth from the mountain." This lasted but six hours, and on Thursday night no light was seen, although the summit was covered with smoke. Four slight earthquake shocks were felt at Waimea and one at Kohala. Those who hastened to Hawaii to see this outbreak were disappointed, but in Kealakeakua Bay they found the runaway eruption. As the steamer approached the bay columns of steam or smoke were seen rising from the sea, much like the spouting of a school of whales, and numerous pieces of lava were floating about.

According to the natives, the eruption was first seen at three o'clock on the morning of the 24th about a mile from shore, and it appeared like innumerable red, blue and green lights. Some thought these were the steamer's lights, only they were so numerous as to excite consternation. Keei Point forms the southern boundary of Kealakeakua Bay, and the steam and lava rose as far as a mile beyond the point apparently from a submarine fissure running about N.N.W. by E.S.E., and where the water has been from twenty to sixty fathoms deep.

Boats from the steamer put off to the scene of the greatest commotion, rowing directly over the most disturbed part where the boat was repeatedly hit by the rising masses of lava, nearly all of which on reaching the surface were red-hot, emitting gases strongly sulphurous. In cooling the lava cakes sank as rapidly as they rose to the surface. Specimens were obtained[101] which are very porous, and from the accounts much of it was the froth called *limu*. A severe earthquake shock was felt on the western side of the bay during the night of the eruption. Eleven years after this, while camping on the shore of this beautiful bay, near the site of Cook's and Vancouver's observatories, I paddled my canoe over the region where this "submarine volcano" broke out and found that it had left no sign. The newspaper accounts were illustrated by most grotesque and impossible pictures of four black columns like trunks of trees and five pillars of fire,—papers of respectability in the United States and Europe. We must now return to Kilauea.

February 2, 1875. Frank J. Scott.—Visited the crater with Mr. J. W. Moore and George P. Castle. Got to southwest side of Halemaumau and stood over the brink of the crater in which the lava stood about forty feet below, and was boiling violently on the edges only. The smoke was towards Kilauea and we could not get to see it, but craters marked C and D were not in action. February 4th, went to the craters again via little sulphur crater marked E, looking down which we saw lava rushing swiftly at a depth of not more than ten feet below where we stood, and in the direction of the hotel. Proceeding to a point of observation marked × we had a fair view of all the craters. The small one marked C was playing with most force spurting its lava in spray ten to twenty feet above its banks. Halemaumau was almost as lively, and the main crater Kilauea was boiling at the base of its cliffs on all sides with vigor. It was about eleven o'clock when we arrived at ×. The little crater D was then without signs of fire. After we had been standing about half an hour, this little basin showed fire, heaving and then bursting its scum of gray lava and boiling fiercely. About the same time the lava in the great crater Kilauea was rising fast. Presently it gushed up and with a surge toward the northeast side, appeared to be rushing toward a vent and in a few minutes it subsided to its first level, and all the craters seemed in about an equal state of activity. None of them were near full as we are told they sometimes are. The lava in Halemaumau was about twenty feet below the lava floor right about it; crater C about the same; D not more than ten to twelve feet, and Kilauea perhaps from thirty to forty or fifty feet. As soon as the great gush from Kilauea found vent we anticipated a good flow of lava on the great lava sink between these craters and the hotel. We returned to dinner at two o'clock via the cave of stalactites on the northeast terrace of the great sink. When we came out from dinner the anticipated lava flow had already submerged an acre or two of the sink on the route of our morning walk and was creeping over the great sink in four different places.

---

[100] Hawaiian Gazette, February 21, 1877. Further account of this eruption is from the same source published by Mr. H. M. Whitney who went to Hawaii.

[101] A specimen is in the Bishop Museum. It is very cellular lava; not at all *limu*.

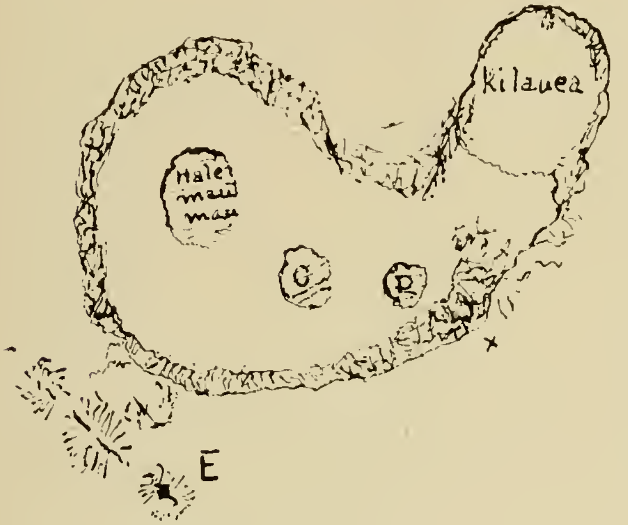


FIG. 75. CRATER IN FEBRUARY, 1875.

August 7, 1875. C. E. Gilman.—Two severe earthquake shocks were felt here today: one at 4:30 P.M., and one at 6:45 P.M. Motion north to south.

August 15, 1875. Challenger Expedition.—A few of our party visited the crater this evening and found both Kilauea and Halemaumau more than usually active. We left Volcano House at 5 P.M., thus arriving at the scene of action a few minutes before sunset. By this means we got a good idea of the whole volcano by daylight and a grand view of the furnaces by night. Kilauea had five jets playing, Halemaumau having the same number but on a much finer scale. Even as we sat there gazing down, Halemaumau rose in a few minutes to within a few feet of the top of its banks, and I have no doubt that an overflow took place at some point that was hidden from us. The lake then subsided to its former level. Between these two craters, high up on the dividing bank of hard lava, a small cone was blowing every two or three minutes, the jets reaching an altitude of twenty or forty feet.—Spectroscopic observations of the furnaces with a small direct vision spectroscope gave a continuous spectrum, the red showing brightest, an occasional flare in the green Magnetic observations were made with the dip needle in front of hotel, then the dip circle was carried down to the first plateau and a difference of two degrees in reading was found, thus indicating the powerful influence of the iron in the crater. Photographs were taken of the whole crater, of the craters of Kilauea and Halemaumau, and of the lava cascades.—Mauna Loa is quiet now.[102]

August 21, 1875. J. W. Gilman.—A faint light was seen from here at 9:15 P.M. on Mauna Loa.

---

[102] The photographs of the whole crater and of the cascades are given in the second part of the first volume of the Narrative of the Expedition, but the two views of the smaller craters mentioned do not appear.

September 7, 1875. Walter M. Gibson.—I descended into the crater in company with Mr. Schaefer and Mr. Gilman of the Volcano House, and arriving at the brink of the Kilauea lake I was disappointed in not finding any show of activity. A small jet of lava apparently not larger than a wheat sheaf, to which some lava jets are compared, was all the outer evidence of activity near the edge of the black surface of cooled lava, at a depth of about a hundred and twenty feet from where we stood. However, after a short stay, several jets broke forth, and before we left Kilauea showed considerable signs of activity. I descended again at 10 P.M. on the 10th September, when I observed a wonderful increase of activity. The Kilauea lake had risen to within thirty feet of the top of its highest bluff, or about ninety feet, whilst the Halemaumau lake and the Kilauea iki[103] pit were full and boiling over, and pouring forth streams of lava, some flowing into Kilauea lake and others flowing in a southeast direction towards the basin of the main crater. I observed a new boiling pool about three hundred yards southeast of Halemaumau and outside of the high embankment that incloses the two principal lakes. After my return to the Volcano House, at a later hour after night had set in, I rode with Mr. Schaefer to a point in the west bank of the great crater, and we observed the two lakes in a high state of activity and illuminating the sky above in a most brilliant manner. During the night we could observe from our beds the jets of lava leaping above the embankments of Kilauea and Halemauman, so that the lava had risen over a hundred feet in these lakes since our first observation on the 7th.

November 23, 1875. C. S. Gilman.—On this date there was at 11:15 o'clock A.M. quite a hard earthquake shock felt in Kau, Kona and Hilo, and another of two shocks, nearly as hard at 7 P.M. The one in the morning threw down several fathoms of good stone wall at Kapapala and also stopped our horses on the road, for the moment, by the motion of the earth.

January 14, 1876. C. S. Gilman.—Last night the lake Kilauea overflowed; a broad stream of lava flowing down into the centre of the crater for some four hours. This morning the summits of Loa and Kea are covered with snow to an unusual extent. Weather clear and very cold.

February 13, 1876. C. S. Gilman.—At 7:45 this evening a very bright light was visible on the summit of Mauna Loa, the first seen since August 11, 1875. It appears to be farther south than the last outbreak. Kilauea very active.

February 22, 1876. Rev. George L. Chaney.—About a mile and a half from the hotel on our way to Kilauea [lake?], we came to an opening in the lava about eight feet wide. Through this opening, in spite of the fierce heat arising from it, we saw a full, rushing torrent of liquid lava, of the brightest flame color, apparently making its way immediately beneath our feet. Both lakes were in fine activity today throwing jets of intense orange-red color from both lateral and medial fountains.

May 2, 1876. D. H. Hitchcock.—Find that Halemaumau has built up about two hundred feet in about one year, and that the lava from the south lake has almost filled up the great central basin. Fires very active; a stream running down the Halemaumau slope the greater part of the night.

June 8, 1876. J. S. Emerson. Visited the South lake approaching it on the north side of the lake; recent lava flows and a tendency to constant changes on the east side rendering the old path from the east unsafe. The lake is quite active and gradually filling up; the surface of the lake has an apparent current or motion in a southwest direction. Weather fine with occasional showers.

June 22, 1876. Herbert C. Austin.—At 9:30 A.M. we were on the edge of the cone looking into the north lake. There seemed to be two boiling cauldrons from which the lava was rolling in great masses of scum to make one complete surging sea.

January 1, 1877. W. P. Toler.—Having made two previous visits, one in 1843, and the other in 1845, I will mention the material differences between now and then. At my two previous visits the entire bottom of the crater was depressed from eight hundred to a thousand feet below the tops of the cliffs surrounding it, whilst now the entire bottom has risen to within four hundred or six hundred feet of the top of the cliffs. At my previous visits the southwest or principal lake of liquid lava was only from ten to fifteen feet below the surface of the surrounding plain of hard lava forming the bottom of the crater, whilst now I find a cone about one hundred and eighty feet high with the lake of lava in centre of cone and depressed about two hundred feet below the top of said cone. Again, on my previous visits there was no flowing lava in sight except in the lake, which, however, was boiling actively all over its surface; and now lava is flowing over the surface of the hard lava in many places. On my previous visits only one lake existed, now I find a depression of about two hundred feet where another has since existed though now extinct. I find also that a large portion of the north cliff has fallen in since former visits. My impression is that taken altogether, the sight is not so grand now as at my former visits, because then the entire bottom of the crater was much deeper than now, and the lake more brilliant in its action, and being nearer the surface was in full view from the point where the hotel now stands, so that our party were all able to read a newspaper by the light from the lake.

---

[103] By Kilauea iki Mr. Gibson means the pool within the Halemaumau area called, unfortunately, Kilauea.

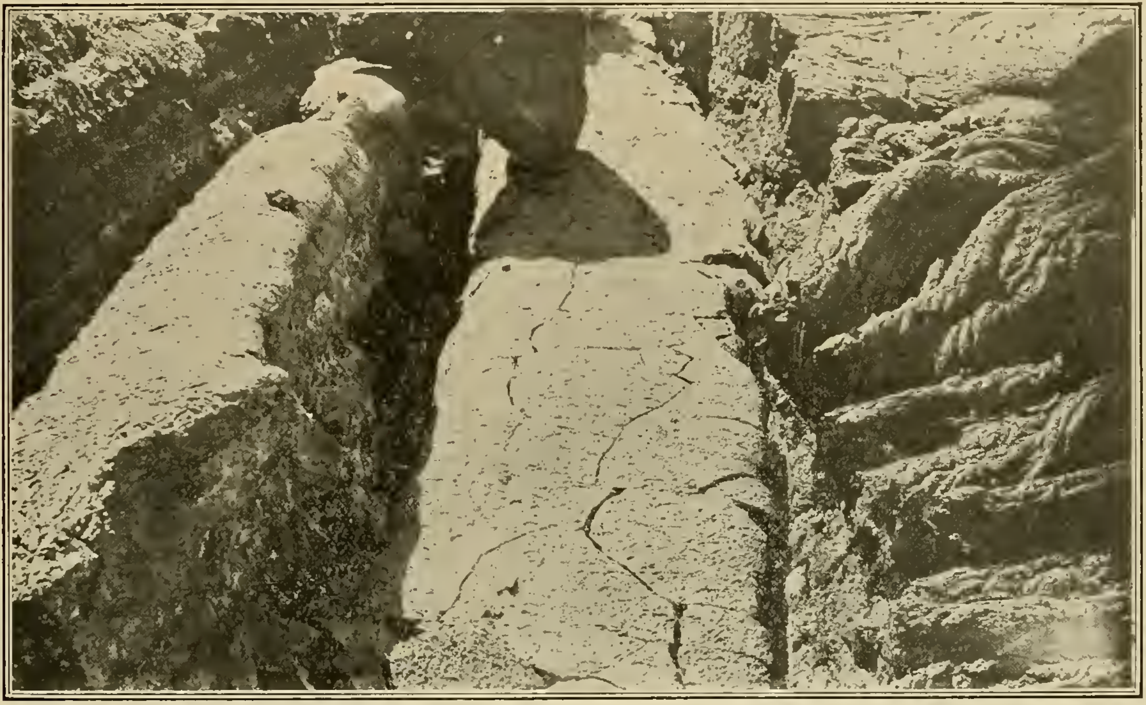


FIG. 76. CRACK IN FLOOR OF KILAUEA NEAR EAST WALL, MAY 4, 1877.

May 5, 1877. A party skirted the edge of the late flow of lava, visited the south lake, then crossed back to the house; saw plenty of subterranean fire and found some red-hot flowing lava.

May 6, 1877. S. B. Dole.—On the day and evening before we came, there was a vigorous outbreak on the southeast side of the main crater, a fissure extending from the crater floor through the bank and into the woods beyond. The lava spouted up from this crack to a height of from fifty to a hundred and fifty feet. This action which drained Halemaumau as dry as an ash heap, ceased before our arrival. We gazed into the empty goblet-shaped cavity called Halemaumau, with feelings wherein terror was mixed with our disappointment. The ledge on which we stood was separated from the main rock by a deep crack so that it appeared to be tilted over the hole and ready to tumble in. Avalanches of stone were thundering down the sides of the hole which appeared to be about two hundred and fifty feet deep. The bottom was covered with boulders.

May 8, 1877. H. M. Whitney.—Found the old south lake dead, inactive, closed to public exhibition. In place of it the fires are active in a large cavern, a thousand feet this way [towards the Volcano House] and near the usual track to the old lake.

May 21, 1877. Thomas E. Cook.—The locality of the outbreak [of May 4] is a mile and a half on a straight line about southeast from the Volcano House, and is from a narrow crevice, narrow that is compared with the quantity of lava ejected. The crevice from which the flow took place commences at the foot of the crater wall and extends up to within twenty or thirty feet of the top, say two or three hundred feet, the lava ejected covering several acres of the floor of the crater.

May 22, 1877. Luther Severance.—No fire in the crater.

June [no date]. H. M. Whitney.—Found the action in and around the south lake commencing, and occasionally the light was very brilliant during the night. Thermometer 56° at 5:30 A.M.

August 2, 1877. B. H. Austin.—Since Wednesday of last week the lake has risen, in our judgment, quite thirty-five feet. We found its fires were very active.

August 12, 1877. Luther Severance.—Crater very active last night.

September 8, 1877. W. H. Lentz.[104]—Bottom of the south lake fell about fifty feet last night.

October 9, 1877. Rev. W. P. Alexander.—I visited this volcano forty-five years ago. It was much more active then than now.

December 24, 1877. Rufus A. Lyman.—Grand flow from north base of hill on the north side of Halemaumau. Two fountains at the source of stream. Some time during this year Wilkes Pea and his father, the latter guide of the Wilkes Expedition found Keanakakoi occupied by boiling lava.

January 18, 1878. Curtis J. Lyons.—Halemaumau is now about four hundred feet long by a hundred in width. Lake Kilauea is to the west of it and not approachable. There is an extensive flow of lava from the north side of the latter, about three-quarters of a mile in length. Present height of cone, estimated, one hundred and seventy-five feet.

September 20, 1878. Dr. J. Mott-Smith.—Halemaumau very active. Kilauea could not be approached, but it, too, is in great activity. A flow from this lake extends more than a mile across the great crater. At night from this house I counted twenty-two spots of fire glowing on the line of this flow. In my former visits, in 1851, '56 and '62, I saw no display of fire to compare with that now seen. The floor of the crater is much changed and elevated since my last visit; all the old landmarks have been obliterated.

October 28, 1878. W. H. Lentz.—The largest flow of the season took place this morning. A solid river of fire three-quarters of a mile long by a quarter wide.

January 7, 1879. H. M. Whitney.—The crater is now and has been for three weeks (or since the heavy rains set in) very active. There are now as formerly two lakes connected [separated] by an isthmus, the old south lake being much larger, and the lava in both rising nearly to the rim around them. But it has not run over the rim, the lava bursting out on one side or the other every few days, making streams which are gradually filling up the central basin. There was an unusual occurrence a few days since,—a stream flowed out on the south side of the south lake, lighting up the whole southern part of the crater. Last night fires were seen in every part of the crater, and it was very brilliant. The hill surrounding the south lake is now higher than I have ever seen it, and parts of it are nearly on a level with the top of the south wall of the large crater. Mauna Loa has presented a splendid sight for ten days past, having been covered with snow down to the forests. The snow fell on the night of December 26th and remained till yesterday, January 6th, when the heavy rain washed it away. Thermometer stood at 50° this morning.

March 18, 1879. A party attempted to ride around the main crater but gave it up after going half way. South lake said to be inaccessible from below.

April 21, 1879. W. H. Lentz.—Bottom dropped out of crater.

April 23, 1879. G. Groeper.—Found the ——— thing extinct.

---

[104] Keeper of the Volcano House.

April 28, 1879. Rev. A. O. Forbes.—Crater almost extinct. Much more steam than usual on the sulphur flat beyond this house. The two lakes of fire have disappeared in the depths of an immense pit from which only a few puffs of smoke and steam arise.

June 24, 1879. W. H. Lentz.—Both lakes very active, Halemaumau throwing jets of lava up at least fifty feet above the rim of lake so often that the lake looks like a fountain of fire from the verandah.

July 2, 1879. W. Tregloan.—One great lake very active.

July 14, 1879. W. H. Lentz.—Eight in the morning a large column of black smoke rising from south lake. 8:10 A.M. large flow of lava from the lake extending over at least one-eighth of the entire floor of the crater. 8:30 A.M. sulphur banks on south side of crater on fire; at 10:30 a large portion of the bank of south lake fell in.

July 15, 1879. Rev. Chas. M. Hyde.—Was greatly interested in watching last night the glow of the burning lava flow extending from the hill straight across to the sulphur bank; it had the appearance of a burning city.

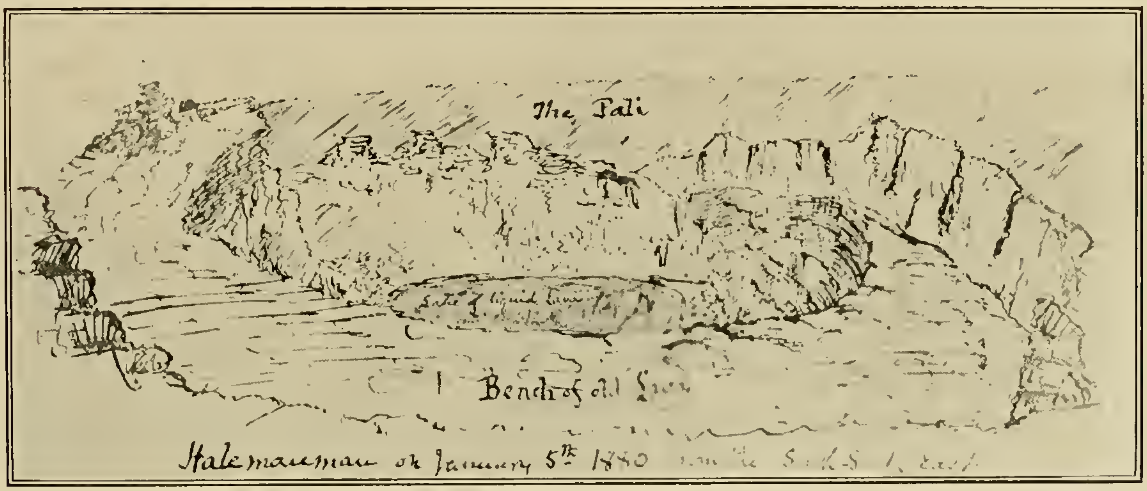


FIG. 77. SKETCH OF HALEMAUMAU, JANUARY 5, 1880.

August 25, 1879. G. H. Luce.—One lake or river quite active.

January 5, 1880. T. J. Kinnear gives a sketch of Halemaumau from the south-southeast.

April 8, 1880. A party ascended Mauna Loa and found much snow; could not look down into the extinct crater.

May 1, 1880. W. H. Lentz.—9:30 P.M. Mokuaweoweo burst out in a large lurid light, with a roar resembling thunder. 10:05 P.M. a second eruption, this time from the crater to the north of Mokuaweoweo, apparently as large as the first. 11 P.M. still another, this time southwest from the first, making in all three active fires on top and slope of Mauna Loa. Kilauea very active, both lakes booming, a third forming, several large flows on floor of crater.

May 5, 1880. A party ascended Mauna Loa and found snow on summit and considerable action in the south lake with high jets of lava.

May 18, 1880. J. M. Alexander.—Halemaumau about four hundred feet broad throwing molten lava over seventy feet high……a new lake forming on the east.

June 20, 1880. W. H. Lentz.—5 A.M. quite a heavy shock of an earthquake; no damage, no change in volcano.

July 24, 1880. W. T. Brigham.—Photographed crater and ascended Mauna Loa from this side.

(PAGES ARE TORN FROM THE BOOK HERE.)

I shall interrupt the Volcano House record to give more fully my observations at this visit, although they have been published,[105] as there are some omissions and additions to be made to avoid repetition and supply lacunæ.

1880

On May 1, 1880, an outbreak from the summit crater of Mauna Loa was reported. Some persons made the ascent and found a fire-fountain from the floor of the small crater adjoining Mokuaweoweo, but this soon ceased and no lava escaped from the crater or from any visible rent on the mountain side. This was unusual, and thinking the slight summit eruption was probably a prelude to a more extensive outbreak, I started in June from Boston for the Hawaiian Islands, taking with me Mr. Charles Furneaux, a well-known artist, that I might be able to preserve for scientific study, should we be so fortunate as to see an eruption, those appearances that the camera does not retain and which are so difficult to describe.

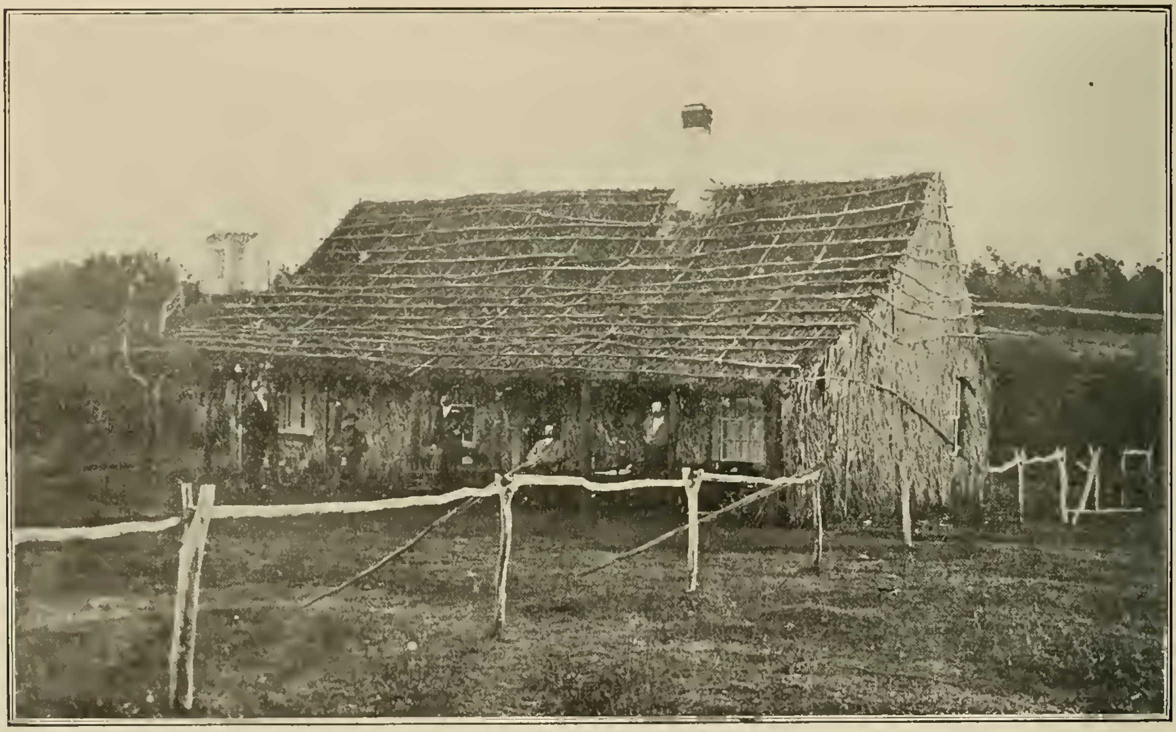


FIG. 78. AN IMPROVED VOLCANO HOUSE.

As soon as possible after our arrival in Honolulu we sailed for Hilo and made the ascent to Kilauea. The road had certainly not improved during the fifteen years since I had last traveled over it, but on the evening of July 24, 1880, with Mr. R. Forbes Carpenter and Mr. Furneaux, I arrived at the northeast bank of the crater where we found a very comfortable hotel replacing the grass shanty I had occupied in 1865, while surveying Kilauea. The scene was familiar. Five times had I come to the crater at night on my way from Hilo, and almost as many times when journeying from Kau, but the wonder of the view never dulled, and tonight the fires far away to the southwest were very brilliant, brighter, perhaps, than I had seen them before.

---

[105] American Journal of Science, July, 1887, p. 19.

On the morning of the 25th, we descended into the crater by the usual path leading under Waldron's Ledge. The temperature on the upper bank was 58° Fahr., and the steam from the many cracks parallel with the crater-walls seemed more abundant than usual. The massive walls had been much broken, and huge fragments of ancient lava had been tumbled down in the path, making the descent much easier, and also indicating more clearly than I had ever seen before, the way in which this vast crater has attained its present proportions. The original walls may have been of small extent, but the jar of earthquakes cracks the not firmly united layers of lava which compose the bounding walls, and finally throws down to the floor blocks of lava in size proportioned to the strength or frequency of the shocks; then the next period of activity in the lava-supply sends over the floor streams of lava which float or melt these blocks, thus clearing away the talus. It is difficult to understand how the lavas raise and float the much more compact old lava, but I have seen it done more than

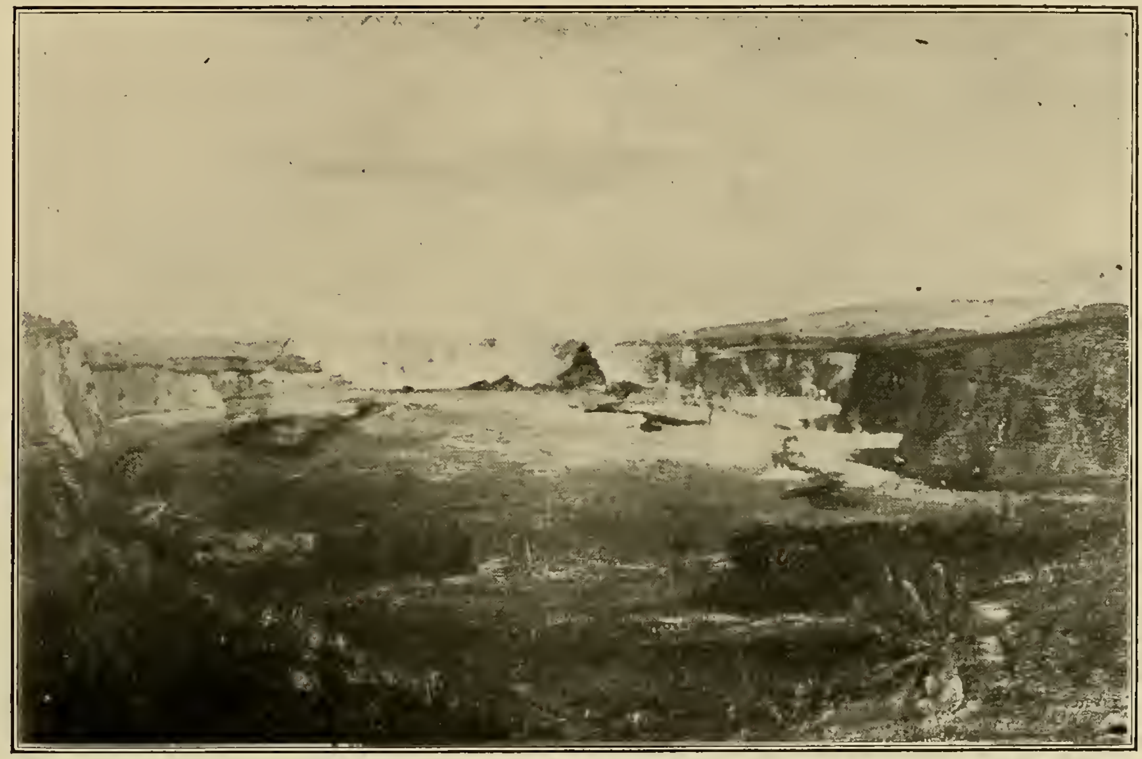


FIG. 79. KILAUEA IN 1880. CHAS. FURNEAUX.

once, and the impression the sight conveyed was of a black hand gently passing under the heavy block and raising it or carrying it along. In the same way lava has insinuated itself beneath stone walls built to bar its progress and lifted and overthrown the futile barrier. So extensively has this process been at work in Kilauea that my survey of the crater, made with great care in 1865, and six years later adopted by the Trigonometrical Survey of the Hawaiian Government and republished on their official map, is already antiquated except in a few points, ascertained by my monuments still standing; the whole boundary has perceptibly changed, and I consider Kilauea nearly five per cent. larger than it was eighteen years ago. The change visible on the bottom of the crater was even greater. I was provided with an excellent barometer, by the kindness of my friend Mr. Carpenter, and found by it that while the bottom of the crater, at the base of the outer wall where first reached in our descent, was 650 feet below the Volcano House, the central portion was only 300 feet, or, in other words, the floor was raised in the general shape of a flat dome 350 feet high. Nor was this hill of lava simply the overflow of the lakes whence the lava runs in frequent outbreaks; the mass was partly composed of these numberless little overflows, but the great mass was evidently elevated in the centre, and the cracks everywhere indicated that this elevation was not a slow cumulative action, but had been, at intervals, greatly and irregularly accelerated.

In 1865 the floor of the crater was very irregular, full of caves and intersected by great cracks, but its general surface was nearly horizontal. A few years later the floor fell in over about a third of its area (see Fig. 69, p. 107) and the caves and cracks were alike obliterated, a funnel-like depression with but slight signs of fire at the bottom. The action, however, continued until the tunnel was not only filled up but the overflow from it reached the outer walls of Kilauea, and then, for a while, the action decreased and the lava cooled. A renewal of activity floated this crust as is indicated by occasional outflows at the edges, and so the intermittent action had in 1880 formed a tolerably regular dome surrounded by four lakes (the latest on the southeast began to form on May 15th) of an average diameter of a thousand feet each. The walls of these lakes of fire were much broken and changing daily. They were elevated in places far above the contour of the dome, and from the action of heated vapors, were decomposed until their layered structure was plainly visible at a distance by the bands of brilliant colors not unlike those of the clay cliffs at Gay Head on Martha's Vineyard. Emerald-green, vermilion, blue and Indian-yellow, irregularly distributed, indicated either very little homogeneity of the masses or uncertain action of the sulphurous and acid vapors. [514]

It was very easy to see what toppled down these fantastic cliffs, for the molten mass within the lake was most active near the edges and under the banks which were generally undermined horizontally to the extent of fifteen or twenty feet by the white-hot, restless waves. From the under surface of these over-hanging shelves depended long and flexible skeins of what seemed to be volcanic spun-glass, or Pele's hair, lapped by the white waves, and seeming, in the glare in which they swung, to be hot to transparency. These pendents were very numerous, often a foot in diameter and six to ten feet long, fibrous as asbestos, and very flexible. Although they were one of the most remarkable appearances at the southeast lake, it was nearly half an hour before I had any direct evidence of the process of their formation. Occasionally surface explosions took place and the viscous fragments, thrown violently against the roof above, spun out in falling back a glass thread, sometimes several from each lump, the fragment being sometimes as large as a man's head. An attraction, probably electrical, as the compass needle is strongly agitated in the vicinity of the currents from the lakes, drew together these isolated threads until the hank was formed which floated like seaweed in a falling tide. Although I watched several hours I did not see any of these hanks fall into the lake beneath.

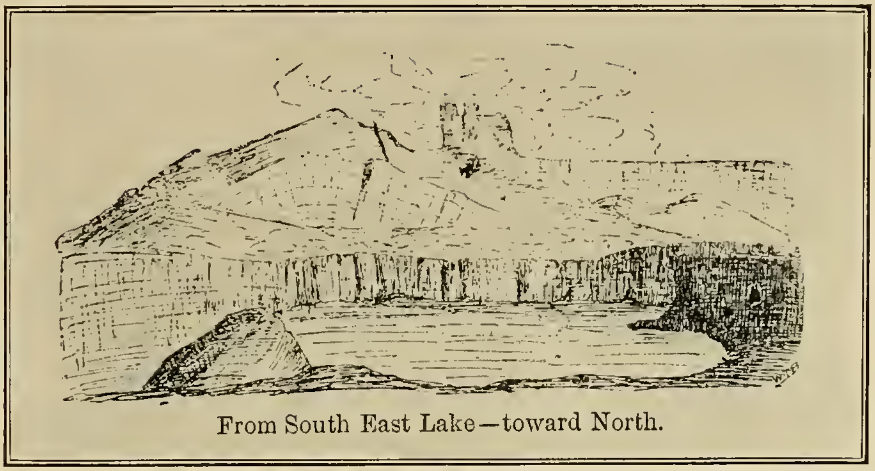

From South East Lake—toward North.

FIG. 80. FROM SOUTHEAST LAKE, LOOKING NORTHWARD.

The brittle nature of the banks which were formed by overflows and ejected matter loosely cemented by subsequent overflows or spatters, would admit of any amount of degradation, but how is the elevation to be explained? A prolonged stay at the crater suggested the following explanation. The action in these fire-lakes or pools, as has often been mentioned, is very irregular and intermittent, often apparently ceasing on one side until the crust there is cool and hard; it then breaks out again from beneath this new crust, turning it back like the lid of a box against the bank to which it may be soldered by the molten spatters, or, as is more frequently the case, the crust is raised *en masse* and where it touches the superincumbent cliff, carries this up with it and sometimes topples it over onto the outer part of the wall. In this way, I believe, the cliffs seen in the sketch, and the whole bottom of Kilauea, nearly three miles in diameter, have been floated up by degrees. If the action was constant the lava would break out along the edges of the swelling plain, as indeed it does when the inflow of lava is long continued, and the surface would become a general level by the accumulation of the running lava in the lowest places. But in fact, after a certain amount of lava has flowed up through the throats, whose position is marked by the surface lakes just mentioned,—enough, it may be, to raise the cool but somewhat flexible crust a few feet in the middle,—the supply ceases; the liquid which has permeated all the cracks and fissures in the overlying crust as the lava on a larger scale injects dikes in the earth's crust, cools and becomes solid, to be in turn raised by a new influx of lava from beneath. Each layer will be thicker near the source and will thin out as the distance therefrom increases, and this is what the cracks and chasms in the dome show so far as one can get into them. The successive layers are very unequal; one not far, perhaps two hundred feet from the outer lake, was six feet thick and contained on a rough estimate ten thousand cubic yards of vesicular lava; next to it was a layer not quite two feet thick and diminishing at a distance of two hundred yards to less than half a foot.

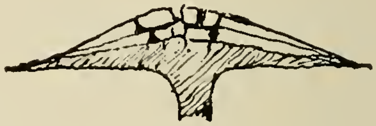


FIG. 81. DIAGRAM OF ELEVATION.

After examining Kilauea by daylight, I procured lanterns and returned to the lakes about nightfall, traversing the bed of the crater while the daylight lasted. A guide (so called) who was at the Volcano House, and who went with us that morning, refused to descend after dark, and the hotel keeper (Lentz) put every obstacle in our way;[106] but I had often been there by night before, and my familiarity with the external action of this volcano made it quite safe to pass over any part of the terrible waste in the flickering, lurid light of the earth-fires, as it is only at night that the Halemaumau can be seen in all its splendor. In some respects also it is a safer journey by night than by day; for example, on our way down we crossed a low dome which gave no signs of fire except a clinking sound and a silent bluish vapor common enough in the vicinity of the lakes; the ground was so hot, however, that we crossed it rapidly to save our shoes; on our return about midnight we found that our path had led over a mound wholly injected with a network of molten lava filling the cracks not two inches from the surface, and which, now plainly visible in the darkness, was a startling as well as a beautiful sight. In daylight the hot lava looks like black tar, and I have several times had to pull my companions from the spot where they might be standing unconscious of the silent black monster which was almost biting their feet, for it was nearly invisible on the equally black floor.

---

[106] *I mention this because it is the only occasion in my many visits to the Volcano House under many different hosts, that I have not met with the utmost courtesy and assistance.*

In all of my previous visits the bank of the active pool had been at least twenty feet above the lava surface, but now we were able to approach the southeast lake nearly on a level, and the effect was much grander than usual. I have spent at various times as many as ten nights in the crater on the banks of this and other similar lakes, and have noticed blue and green flames playing over the cracks in the surface, but these seldom lasted longer than a few moments, and were not confined to any locality. Now, on the contrary, on the top of a huge hummock which seemed to have broken from the bank, was a cluster of blow-holes from which escaped constantly a large volume of gas which burned with a bluish-green flame well shown in Mr. Furneaux's painting of the lake made on this visit. (See frontispiece.) These jets were burning in the morning, and twelve hours after their volume was apparently unaltered. The pressure evidently varied but slightly, and any increase in pressure did not seem to correspond to greater activity in the molten lava. With suitable apparatus it would have been possible to have collected the gas before it was consumed. Its escape caused a noise similar to that of a steamboat blowing off steam. The mention of steam leads me to express a wish that those geologists who see in steam the prime cause of volcanic action, could have been here, and have studied an eruption of the Hawaiian volcanoes. A pailfull of water thrown into the southeast lake would have made more steam than was present all the time we stayed in the crater. It is difficult to mistake a steamy atmosphere for a very dry one; and then if steam was present in any quantity in the gaseous exhalations of Kilauea, the cold winds from Mauna Loa would soon precipitate it as rain, when in fact this is the dryest part of the island.

The ancient Halemaumau or Everlasting House, where fires have been seen, or whence vapors have escaped from time immemorial, was now replaced, I believe, by the four lakes which occupy the position of that single source. The guide and others insisted that the northeastern of the lakes was the Halemaumau, and without renewing my survey, for which I did not have with me the necessary instruments, I could not positively declare that they were wrong, but I sighted from two of my monuments left from 1865, and comparing with my notes of that survey on my return to Boston, I found that the Halemaumau of that day occupied a position nearly southwest of the present so-called Halemaumau, or in the midst of the present four lakes, so that no one of them is entitled exclusively to that name sacred to the ancient worshippers of Pele.

Among other changes the southern sulphur bank had wholly disappeared, having been consumed by a local outbreak of lava which occurred a few months before our visit (July 14, 1879). The other deposit of sulphur on the north side near the hotel seemed smaller, and the impression conveyed was of a much smaller amount of sulphur in and around the crater than was found fifteen years before. None of the fine crystals so common then could be found now.

West of the crater on the Kau road, in the region called Uwekahuna, are many small cracks which indicate plainly a general and extensive subsidence. Farther to the southwest was a long line of smoke or vapor extending, it may be, to Ponahohoa, where Rev. William Ellis found marks of a recent outflow in 1823. I could not then follow the fissure, nor do I know of any one who has done so, but this is the track of many an eruption, and should be thoroughly surveyed, as it is little visited, being barren and of rough surface. (This has since been done to some extent by the Government Survey.)

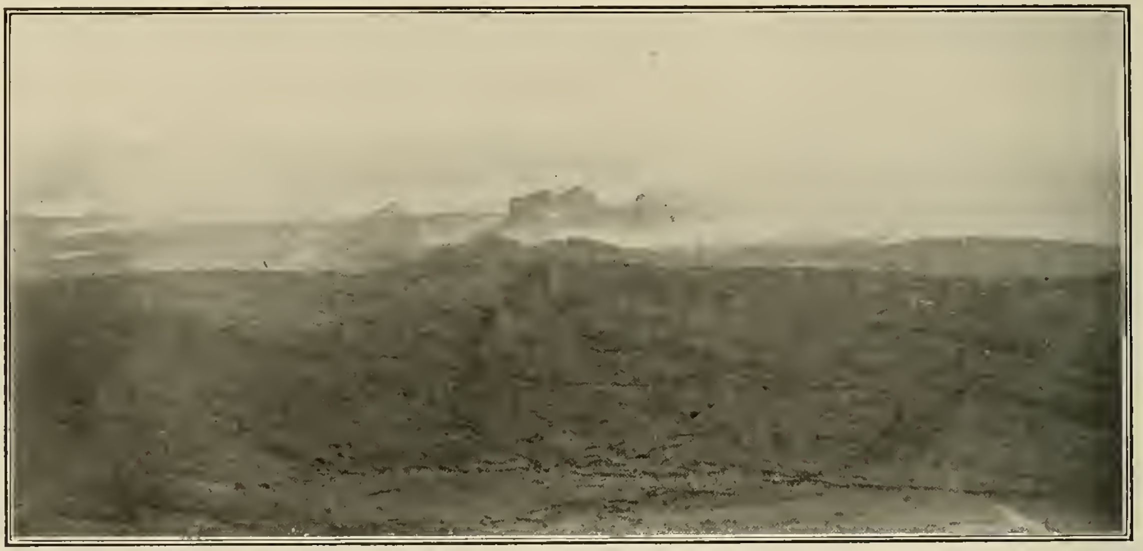


FIG. 82. HALEMAUMAU FROM KAU BANK IN 1880.

As the moon rose about midnight we started for the upper bank and the Volcano House. The brilliant moonlight of the tropics glittered on the metallic lava in cold contrast to the hot fire-light we had just left, and as the shadow of the high ledge fell across our path we had to walk warily and in single file to avoid the cracks our feeble lantern hardly indicated. Once on the path up the wall, we separated, and the most active got home half an hour before the rest of the party.

On the twenty-ninth of July, having in the meantime made the ascent of Mauna Loa, I returned to Kilauea. In the afternoon I went to the Kau bank, and while Mr. Furneaux sketched Kilauea from the west, I photographed the cliffs of Halemaumau, and then descending two of the gravelly terraces which form the border of the crater on this side, found myself on the brink of a perpendicular cliff beneath which the lava was escaping from several openings situated on the lower edge of the dome. The action was curious, and although the heat was very great at this height of nearly a hundred feet, I managed to watch and sketch it for nearly an hour. The noise here was peculiar; for in addition to the clinking as of shivering glass, usually heard when this black and glassy lava cools, there was a dull subterranean rumbling as of heavy machinery moving beneath the crater. It was the same noise I had heard during an earthquake two days before at Stone's ranch many miles from Kilauea, and it was not unlike the sound of many looms in a cotton factory. Here there was no earthquake tremor, although there is always in and about Kilauea a vibration of the ground very clearly seen when using a compass needle, but seldom noticed otherwise. The cliff where I watched was not over the lowest part of the crater, but was where the active pools approached nearest to the outer walls, for the dome has a very excentric apex. The fluidity of the lava as it came to the surface was about that of cream. There is, so far as I know, no definite scale to which we may refer various degrees of viscidity, and I am compelled to use homely comparisons, which have the further disadvantage of being a variable standard. It was white-hot cream when it came out from under the crust, but in the distance of perhaps a foot had changed to a cherry-red molasses, while a few feet more transformed the stream into full red tar. By daylight the color ranges from that of arterial to venous blood, and thence to a slaty blue, marking the loss of temperature by chromatic changes. At night all the moving portion is a bright red. A single outlet of small dimensions made much noise blowing, although the gas expelled was invisible. The lava (A in the diagram) issued white-hot, ran a few feet rapidly, then crusted over, retaining its red glow along the edges of the narrow conduit, C. At B there was a contraction and the flow stopped for a while; then the fountain at A renewed the supply and the lava ran rapidly from the narrow outlet B, spreading in a broad, thin sheet which did not lose its color until it reached the point E, while the original nar-

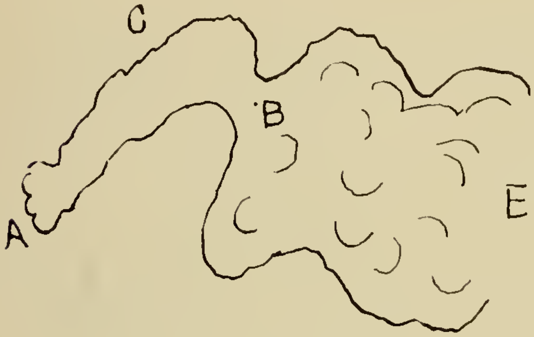


FIG. 83. LAVA SPRING.

rower and thicker stream had formed a crust and become black in less than a quarter of the distance. In places the lava met upward inclines, then the cooling, but still flexible, crust, made a dam and carried the fluid part up and over a rise of some feet. The little lava spring was an epitome of a full lava flow, and was more instructive than the immense fiery floods that from time to time break out from these volcanoes and flow for many miles. Later in the evening this insignificant flow became more active, covering twenty acres and giving more light than the lakes themselves.

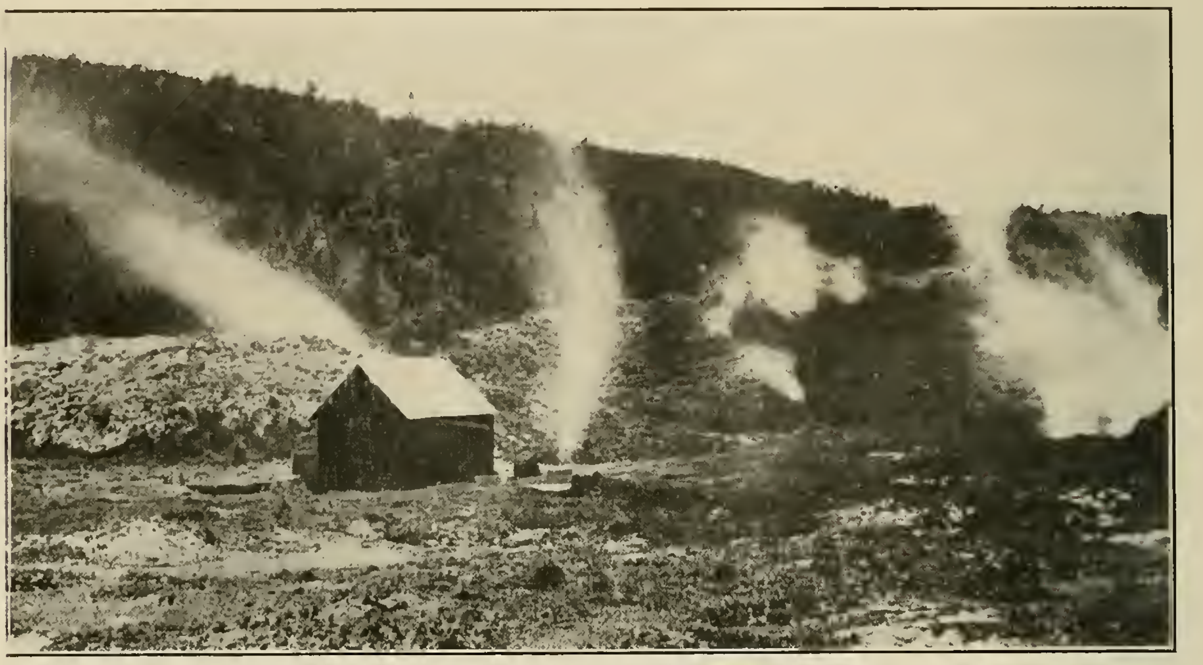


FIG. 84. BATH HOUSE ON THE SULPHUR BANK, 1880.

Over one of the steam cracks near the Volcano House, on the northeastern bank, and in close proximity to what remained of the sulphur bank, had been built a very rude steam bath. A hut of ample dimensions, a box with a stool in it, and loose boards to fit around the neck of the bather, with a wooden sluice from the steam crack to the box and a slide to regulate the admission of steam, constitute the entire apparatus. Seated in the box late that evening, in utter darkness, while the attendant had gone outside with the lantern to get a pail of cold water, I heard, in the stillness, sounds deep down in the steam crack, rumbling and hard noises totally unlike the soft hissing or sputtering of the steam. Fearing that my imagination lent strength if not being to these sounds, I went to a crack outside and, at the risk of pitching in head-first, listened carefully. The same noise was heard distinctly, not unlike that of an earthquake, but feebler.

NOTES ON AN ASCENT OF MAUNA LOA IN 1880, ABOUT THREE MONTHS BEFORE THE GREAT ERUPTION OF THAT YEAR. BY W. T. BRIGHAM.

From the American Journal of Science, July, 1888, p. 33.

On the first of May, 1880, fire was seen in the crater of Pohaku Hanalei[107] (B in Fig. 85), on the summit of Mauna Loa. Persons who made the ascent saw a fire-fountain much like that observed in 1872, but no overflow followed, and the fires soon disappeared. On the morning of July 26, I left Kilauea for Kapapala. The next morning, while waiting at Stone's ranch for a guide over the trackless beds of aa and clinker on the great mountain, an earthquake occurred at 8:30 A.M. local time. It lasted three seconds, and was accompanied by a loud subterranean noise resembling that of the looms in a cotton mill. The vibration was by no means so noticeable as the noise. Journeying over a grazing land covered with coarse grass, and dotted here and there with blighted koa trees, we reached Ainapo at 1:45 P.M. Although at an elevation of at least 5000 feet, the temperature was at 75°. Late in the afternoon I mounted a fine mule that had been loaned me by a friend, and, with Ahuai for guide, left the ranch. In 1864, with Mr. Horace Mann, I climbed the mighty dome on foot on the opposite side; but this path was, if possible, worse. The forest had been burned, and the blackened stems of the trees were dismal objects unless covered with the *akalá*, a gigantic raspberry vine. The soil in these lower regions seems good, but the ground is much broken, and so full of holes that it would be very dangerous to ride out of the trail after dark. Even in the afternoon, vapors ascended from these holes, which often, if not always, communicated with caverns in the ancient lava streams, and as the day waned the vapors became more distinct. I found as the average of several trials, that the temperature was only two or three degrees higher than the outer air. As we ascended, the actual temperature of the vapor in these holes increased, and of course the relative temperature was much higher. I inferred from this that the inner mountain mass was hotter than usual, as I had never observed so great a difference before, and that an eruption was at hand.

At the upper limit of vegetation we camped, giving our animals the little bundles of hay we had brought for the purpose. The night was cold and on the morning of July 28th, at sunrise, the thermometer marked 52°. We broke camp at five o'clock and reached the summit at half-past ten. A rougher mass of lava I have seldom seen and never before ridden over. Beds of aa were succeeded by piles of jagged scoria in fragments from one to twenty cubic feet in bulk, and over these my mule jumped like a chamois. At last we came upon a level plain from which had poured the lava that had hindered our ascent.

---

[107] This name was applied by my guide to the south pit crater of Mokuaweoweo, and I still believe it the correct name. This name was also used by Wilkes in 1841 with the concurrence of Dr. Judd and others. Much juggling has taken place with the names of Hawaiian origin in later times, and this name has been applied to at least three craters on this mountain. The one selected by the survey (on what grounds I do not know) to bear the name on the official map is a cone on the summit some distance from Mokuaweoweo in a northeasterly direction. I may add that in the Journal of the Royal Geographical Society, xxv, 194, in a paper by J. G. Sawkins, read June 25, 1855, there occurs this passage: "The crater of Pohakuhanalie is connected with that of Mokuaweoweo, which is much deeper, its walls being nearly perpendicular, and exhibiting 92 layers or beds, uninterrupted by dykes. South of the last named crater there is another, the lava of which was so hot at the time of my visit that we could not walk over it."

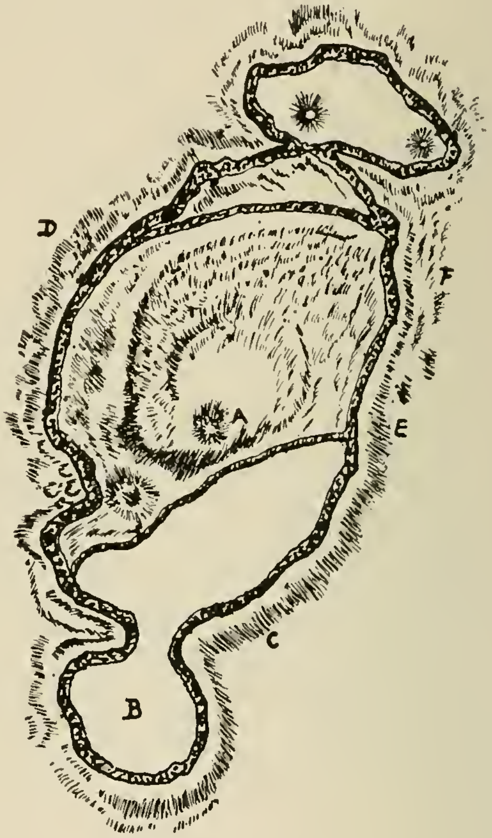


FIG. 85. MOKUAWEWOEO.

Although we were on the summit, the crater, Mokuaweoweo, did not at first appear, but on every side were rough piles of lava, some recent, and abundant deposits of the vesicular lava called *limu*. This limu is of a pale green color presenting at a distance the appearance of vegetation. Some fragments of it were a foot in diameter, the exterior glazed and of a much darker green, the whole very vesicular and so full of air as to float on water. In appearance it was frozen froth. In the midst of this waste plain we found the crater. Since I saw it fifteen years before great changes had occurred. Then no change but the gradual decay of time seemed imminent; all was the repose of the dead. There were some concentric cracks in the outer walls, but the lava between these cracks and the crater itself was so solid as to retain snow and ice all the summer, and the descent into the crater could be made only where the smaller craters broke into the outer wall. On both the east and west sides the precipices of gray, scarred and compact lava rose to the height of nearly a thousand feet, and seemed coeval with the mountain. At the present time these ancient walls were cracked and tottering to their fall; in some places they much resembled a wall of loose stones artificially laid. It was dangerous to approach the brink (of the south crater) so loose were the lava blocks, and the vibrations caused by my approach seemed to extend downward several hundred feet towards the talus which had been the result of a tremor more severe than usual. By lying down I was able to look over and test the height by timing the fall of stones. The bottom of this lateral pit, as of the main crater, was comparatively level, without cones, and gave no indications of the source whence the fresh black lava had issued. At my former visit in 1864 there were two cones in Mokuaweoweo about two hundred feet high near the eastern wall. In 1870, when Mr. Luther Severance ascended the mountain, there were no cones, although the bottom was much broken and sloped from west to east. From his sketch we learn that at *f*[108] the wall was very steep; at *e* the height was estimated at 1200 feet; at *h* were sulphur banks smoking, but not violently; *c* marks the point where the trail from Kapapala ends; *d* the point where Mr. Mann and I came to the crater in 1864; *D* is the small southern crater, and *a* is where I found the wall tottering in 1880.

In 1874 the crater was surveyed by Mr. John M. Lydgate, of the Government Survey, and the cones had again formed, two being in the northern lateral crater, and two in the main pit. In 1880 with this survey before me,[109] the changes seemed to be mostly in the outer walls which had crumbled extensively, changing the outline, but not enough to be indicated on a plan so small. In addition, the cross walls E and F were obliterated, and the bottom of the crater was covered with fresh lava. On this, along the edges, was a talus of old lava from the walls, showing plainly that an earthquake had occurred since the eruption of May 1. No sulphur banks or steam jets were seen from either *c* or *a* and the deposit of limu, added to the roughness of the lava, deterred me from making the circuit of the south pit to examine a very extensive break on the farther side which looked fresh. Near the break was a black and glistening stream of lava, like that at the bottom of Mokuaweoweo, which extended from the opposite bank as far to the westward as could be seen over the undulating surface. Whence this issued was not easily determined. If it was, as first appeared to be the the case, an overflow from the crater, how could this have been full and yet have left no fresh lava on the broken walls? Usually when a pit crater fills up and is emptied from beneath, the sinking lava leaves a rim or "Black Ledge;" but there is nothing of the sort here. If the stream flowed *into* the crater then the wall over which it came has tumbled down and so removed all traces. I finally concluded that it owed its origin to some of the inclined lava jets that spouted out clear of the crater.[110]

My guide had seen the fountain of May 1, and he assured me that it came up level with the outer walls of the south crater, so that the top was visible as he was lying down some distance from the brink. This would indicate a height of nearly a thousand feet,—not an insignificant jet!

I was convinced that the eruption of May 1 was but the *avant courier* of a greater one, and as the termination of my visit was near, I asked those who were interested in these matters to watch for events and report to me. The new eruption began on the fifth of November, and it proved the beginning of the most extensive lava flow that has been recorded from the Hawaiian volcanoes.

---

[108] For these references see Survey of Mokuaweoweo, p. 159.

[109] See Survey of Mokuaweoweo by J. M. Lydgate, Fig. 73.

[110] In that I was mistaken, as a subsequent survey found an eruption had taken place from fissures near the brow of the cliff, and a later eruption had flowed into this pit. See Survey of 1886.

We will return to Mauna Loa, for my expectations, aroused by the news of an outbreak in May, although unfulfilled so far as my participation was concerned, still materialized in a most definite manner about six weeks after my return to Boston. Here is the story from Mr. Coan about as it came to me:

> Hilo is in a haze of sulphur smoke, and we see the sun as through smoked glass. We have a grand volcanic eruption. On the first inst., a little before daylight, a herdsman who lives about two miles out of town, reported that he had seen a light on Mauna Loa. At 8 P.M. of the same day, my wife called my attention to an unusual light in the direction of the mountain. At first it was partly obscured by clouds, so that we hesitated to pronounce it volcanic. In a few minutes, however, the revelation was clear. The clouds dispersed and the spectacle of a burning mountain opened to our sight. The action was intense. The appearance was as if a vast column of melted rock, a mile in diameter, was being poured out of the mountain with amazing force and vehement heat. Brilliant corruscations shot out in all directions, lighting up the clouds to the apparent height of 30° and spreading out for many miles along the summit of the eastern side of the mountain. The outbreak was in full view from the west side of our house, which was brilliantly lighted up by the fires, while the front part was in a deep shade, rendering the contrast striking.
>
> This eruption occurring in the night, we were unable to determine at once the exact locality. Some thought it was in the deep summit crater, Mokuaweoweo [as it was]: and others that it was at a point a few miles north of it. Since that night the mountain has been so veiled in clouds and smoke that we have not been able to see the fire. Yesterday flocks of Pele's hair, and light particles of volcanic dust and sand were dropped upon our houses and in our streets, having been borne upon the winds for this great distance.
>
> Since my former letter, dated June 20, 1879, Kilauea has resumed great activity. Rarely in its recorded history have the fires been more intense or the filling up more rapid. Lateral streams of liquid rock are bursting through the scoriaceous sides of Halemaumau and flowing down the declivities into the central depression, adding stratum to stratum, while the great lake boils, and dashes its waves against its walls, and sends its burning spray high into the air. The debris around the high walls of the lake is so hot and brittle that most parties who visit the crater do not venture near the burning cauldron, but mount some quiet eminence about one-quarter of a mile from its margin, where they can witness its ragings, and listen to its splashings and mutterings with safety.[111]

October 27, 1880. L. P. Tenney.—Halemaumau is quite active, as is also Kilauea or South Lake.

November 4, 1880. W. B. Oleson.—The lava is flowing on the west side of the crater [main], and quite perceptibly changing the level. There are three distinct lakes without any other than underground connection. Kilauea is crowded into very small dimensions, while Halemaumau remains in outline about as it was a year and a half ago, but not being accessible, no definite idea of its condition could be learned. Apparently the lava has sunken to a great depth, as no sounds could be heard. The special seat of activity was in a new lake toward the southeast, not far removed from Halemaumau. Here there was a vigorous activity, though nothing violent......I have seen two of these lakes when there was a rapid flow of lava alternately from one to the other, and at a time when there seemed to be less activity than at this visit.

November 12, 1880. W. H. Lentz.—About 9 P.M., November 5th, a flow of lava started from the northern slope of Mauna Loa apparently towards Waimea or Hilo, and is still running.

---

[111] American Journal of Science, xx (July, 1880), 71.

On November 9th, about 8 P.M., the above flow started a branch along the slope and face of the mountain towards Kapapala ranch, Kau, and is still on its journey, making, I should judge, eight to ten miles a day.

December 7, 1880. J. M. Lydgate.—Result of one day's half-hourly observations with two mercurial syphon barometers, one being observed here, the other at Hilo: 4021 feet above sea at Volcano House.

The flow from Mauna Loa which was observed from the Volcano House on November 5th, proved to be the expected eruption which had brought me to Hawaii, and from the duration of its flow, the distance reached by its several streams and the amount of lava poured out it is to be reckoned one of the most important on record.

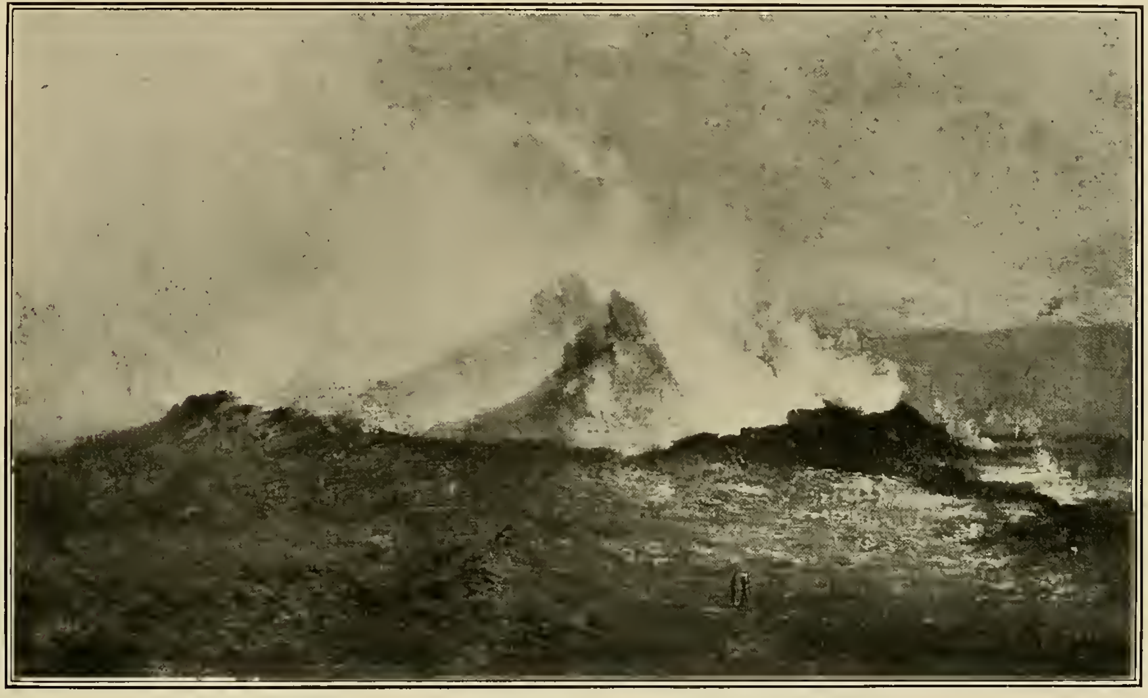


FIG. 86. VIEW OF HALEMAUMAU IN 1880. FURNEAUX.

On the evening of the 5th, the light was first seen from Waimea, north of Mauna Loa, and a few hours later from Hilo on the northeast. In both cases the lava fountains were distinct, leaping high into the air. This was quite like all former recorded eruptions, but in one way this differed from them all, and that was in the diffuse way in which the streams were poured out; the length of time the lava poured forth was also a noteworthy fact, over nine months. From below the first stream seemed to run north by east towards Mauna Kea, but this stopped after a course of twelve miles, not far from the sheep station of Kalaieha on the high plateau between the great mountains of Hawaii. I have seen the end of that stream and it presents no marked peculiarities; the supply at the fountain was evidently diverted,—Rev. E. P. Baker visited the source several times, and gives us the result of his observations seven years after. The diagram (Fig. 87) will render his explanation clearer. At the end of a large crack about eleven thousand feet above the sea, where is now a pit crater (S) of considerable size called Pukauahi, the flow came to the surface. The crack was on a "divide," and while the Kea stream started first it probably blocked in some measure the discharge, and another stream, called the Kau flow, started in the direction of Kilauea a little higher up the crack. This Kau flow was well seen from the Volcano House at Kilauea, and for a time it looked as if the lava would reach and flow into the latter crater. Numerous branches flowed down the crest on its southeastern slope, and they are quite easily traced from the House, in suitable conditions of light, to the present day. The crack ran by the north of a red cone which in July, 1888, was still smoking, and also a smaller cone (marked V on the diagram) which was also smoking seven years after the eruption ceased. Dana seems to follow Baker in considering these cones the obstacle that turned the main stream toward Hilo, but while the matter is unimportant, it seems from the continued activity that they were a part and parcel of the eruption, and did not exist before.[112] Mr. Furneaux' sketch (Fig. 88) shows the red hill in the centre of the view. In the original sketch the hill is of a brick-red color, and the curious ribbon of lava in the foreground is of a greenish tinge, and the pinnacle and ridges of various shades of red and brown contrasting well with the patch of snow on the left. Steam was still issuing from the cone and other parts of the flow when the sketch was made.

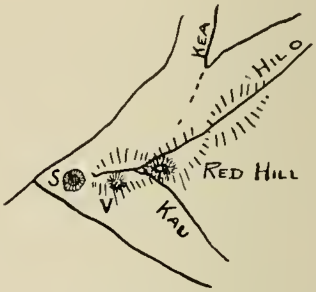


FIG. 87.

After four months the flowing lava was about seven miles from Hilo; on June 28th, within five miles; on July 18th, two miles, and on August 10th, it finally stopped three-quarters of a mile from Hilo. Great was the anxiety as the stream approached the apparently devoted town, not only in Hilo but all over the group, for the beauty of the town and the hospitality of its inhabitants were known to all. I am tempted to quote at some length from letters which show the nature of the flow as well as the state of mind, for so wonderful are these flows, so spectacular as well as scientifically interesting, that the words of no one man, however eloquent, can picture the whole scene. I give extracts from the letters sent to me, and others published in the daily papers, but all from those well known to me and whose knowledge of the phenomena was not that of mere transient visitors seeing such wonders for the first time. The first is from my friend of long time, the late Judge David H. Hitchcock. It is dated from Hilo, Thursday, June 30, 1881:

---

[112] Characteristics of Volcanoes, 205, and American Journal, xxxvii, 53, already quoted.

> About Wednesday of last week, the old mountain was observed to be more than usually active, the whole summit crevasse pouring forth immense volumes of smoke. By Friday noon the three southern arms had all joined into one, and rushing into a deep but narrow gulch forced its way down the gulch in a rapid flow. By Saturday noon it had run a mile and was just above John Hall's house on the south side. On Monday morning it was reported to have reached the flats back of Halai Hills. My wife and self started that afternoon with the intention of spending the night alongside the flow. We met crowds of people returning from the flow, and all reported it active and coming rapidly down the gulch. We rode up to it before dark and found that the stream was entirely confined to the gulch and intensely active. It was then about half a mile from the flats spoken of.

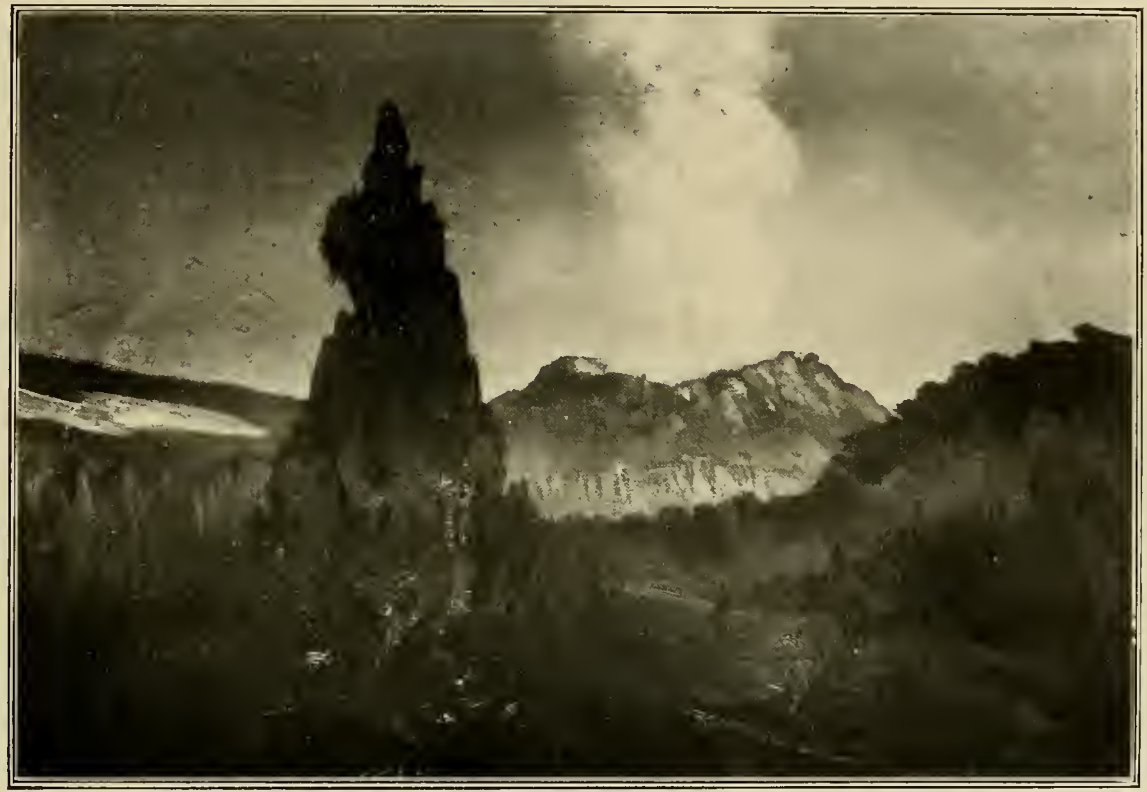


FIG. 88. VIEW OF THE SEAT OF THE ERUPTION OF 1880. FURNEAUX.

> The flow was on an average about seventy-five feet wide and from ten to thirty feet in depth as it filled the gulch up level with its banks. The sight was grand. The whole frontage was one mass of liquid lava carrying on its surface huge cakes of partially cooled lava. Soon after we arrived the flow reached a deep hole, some ten or fifteen feet in depth, with perpendicular sides. The sight as it poured over that fall in two cascades was magnificent. The flow was then moving at the rate of about seventy-five feet an hour. About midnight we noticed a diminution in the activity of the gulch flow and soon saw a bright red glare above the tree tops mauka [inland] of us, and were presently startled by the burning *gas bursts*, and the crackling and falling of the trees somewhere

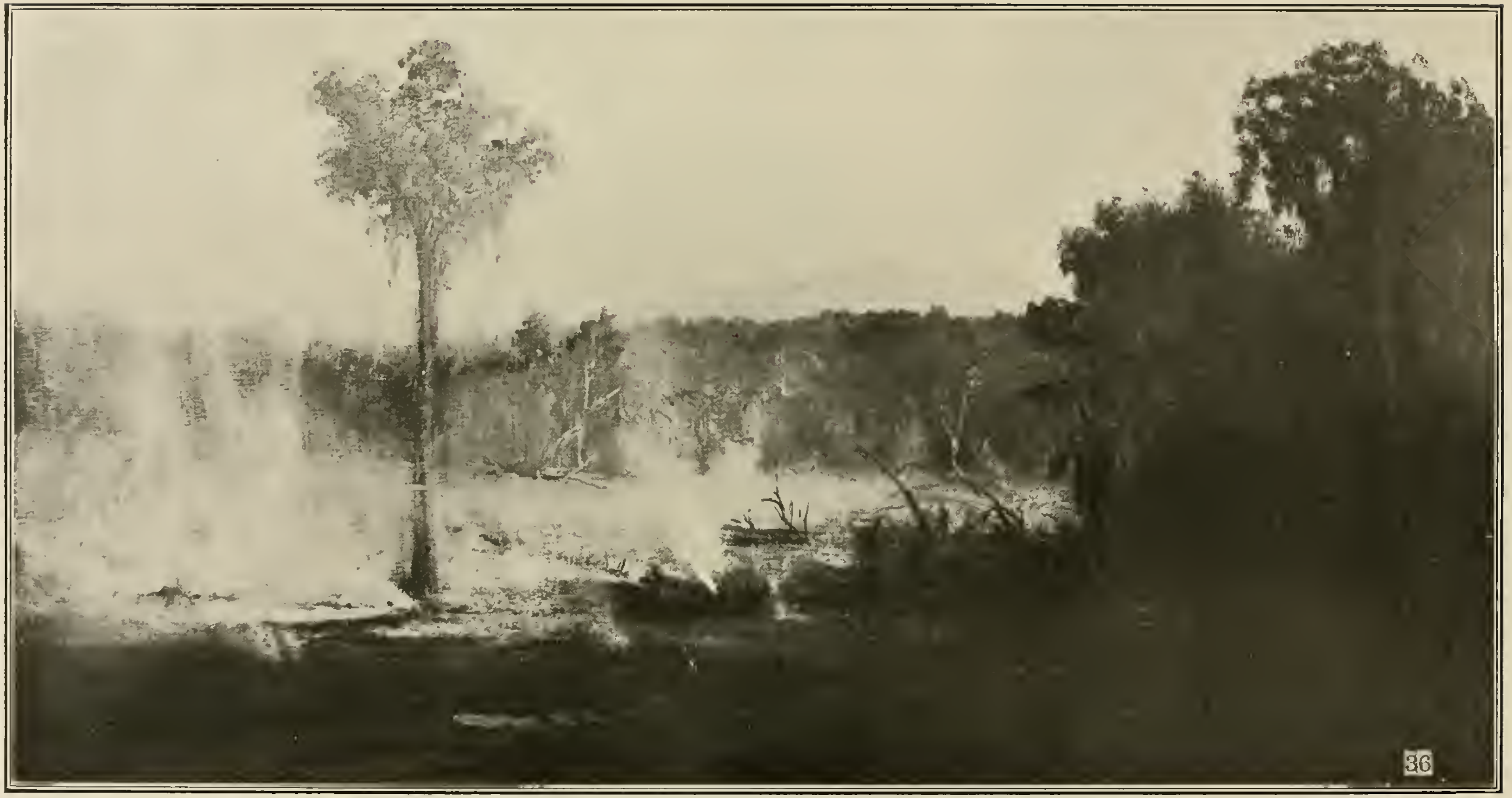


FIG. 89. LAVA STREAM IN A FOREST. FURNEAUX.

above us. The whole sky overhead was lined with the light of burning trees and shrubs. About 2 A.M. we made the attempt to reach the scene of the great activity, and succeeded by going up the south side of the gulch some quarter of a mile. And what a scene lay before us as we ascended a slight elevation! The oncoming overflow had swept over the banks of the narrow gulch and was flowing like water into a dense grove of neneleau [sumac] and guava trees. There they stood in a sea of liquid lava over a space of more than an acre, while the fires were running up their trunks and burning the branches and leaves overhead. The flow was so rapid that the trees were not cut down, for more than two hundred feet from the first of the flow. In one place we saw a huge dome of half melted lava rise up fifteen or twenty feet high and twice that in diameter and apparently remain stationary, while the fiery flood went on.

The reasons of the quick advance of the flow the past two weeks have been the increased activity of the fountain head; the junction of the streams mentioned above, and the fact that this narrow rock bed gulch has formed, as it were, a *flume* to pass the liquid lava along in a solid, narrow stream, without any chance for spreading out laterally.

Extracts from letters of the Rev. Titus Coan:

Hawaii is still on fire, and the smoke and sanguinary glare appear like a line of soldiers in battle. The northern wing of the line is less than six miles from us, and the southeastern is less than five miles distant, while the centre of the line appears the most sanguinary. From the southeast wing the seething fusion has fallen into a rough water channel, twenty to fifty feet wide, which comes down from the main bed of the flow almost direct to Hilo, entering into the Waialama stream, which cuts the beach about midway. In this way the lava at white heat is fast approaching the shore. It is now only two and a half miles from Volcano street and it is very liquid, running much like water. It has, some part of the time, run at the rate of half a mile a day. Our town is greatly moved, and some have suspended all other business to watch the fires. The main body of the fire is moving slowly down upon us in sufficient breadth to sweep our whole town, while the small stream is like advanced pickets on a skirmish line. We are in the hands of our All-wise and Gracious God, and would not be elsewhere. Let Him do according to His pleasure, while it is a comfort to call upon Him in the hour of trouble, and hope in His mercy.

Tuesday, 5 p.m., June 28.—Mrs. Coan and I have been to the lava flow today and returned. We were a little over an hour in reaching the flow, walking our horses slowly all the way. A native with a good horse will reach the fires in forty minutes, and return in thirty. We call the distance three miles. We found two streams of liquid lava coming down in rocky channels which are sometimes filled with roaring waters, but nearly dry at this time. These two gulches are too small to hold the seething fusion, and the fiery flood over-runs the banks, and spreads out on either side. The united width of these streams may vary from fifty to two hundred feet. In going down the steeper parts of these rocky beds the roar is like that of our Wailuku, or our surf, and often like thunder.

The visit to the flow which Father Coan dismisses in so few words, Mrs. Coan describes in a letter written the evening of her return, and I quote portions of this letter:

This has been the darkest day that Hilo has known in connection with the flow of 1881. We knew by the glare of the sky last evening that there was increased activity, and we both said that at no time had the look been more threatening. There was such a broad belt of light, and it looked so near. Before breakfast this morning a native came who had been at the Waiakea flow and told what he had seen—a startling story; but we have become so distrustful of all the native reports that we could not allow ourselves to be much alarmed until we could hear further. Mr. Coan, soon as he could, went down town to get more reliable information, and when he returned, I asked eagerly: "How is it?" and he answered, "Well, *it is all true!*" He had seen several who had been to the flow and the reports all agreed. We are feeling sober, for truly we know not but that destruction awaits our beautiful homes—and where shall we go? The people in the Kukuau apana [district] are moving their things and themselves.

June 29.—Ah! How can I tell you the story of yesterday? I look back upon it as a dream of the night, and yet the experiences, the sights, were actual. We had an early breakfast and a little before nine were ready to start for the flow, our Portuguese John accompanying us. When we reached the turn in the road on the Puna side of the cemetery, there burst suddenly upon our view the spot to which the fire had progressed. And it looked alarmingly near, not more than a mile distant; but as we rode on the distance increased and we found we went two miles or more beyond the further one of the three crater-hills. As we followed the trail, others passed us at more rapid rate, and among them the Lymans and Severances with native attendants, and we found many there when we reached the place. A few rods of walking after we dismounted brought us to the margin of the stream, not limpid, sparkling brook, such as one might have looked for in that lovely, emerald oasis, but a red-hot, madly pursuing, death-dealing flow of lava. Years ago, and not so very many either, people lived thereabouts and the land was under much cultivation (Mr. Coan has often been there,—there was formerly a school-house not far from the place), and you can easily imagine what luxuriant growth of grass there would be, and what strong, leafy guava bushes, in what had become almost swampy land since the soil-tillers had abandoned it. But right over this freshness and beauty the flood was coming. More was to be seen beyond, so we pushed eagerly through tall ferns and bushes of ueuelean, almost held in our steps by the sticky mud, till we reached a rocky gorge which in times of heavy rains is the channel for the stream that rushes down a perfect torrent to the sea passing under the bridge near the little church at Kalepolepo. This gorge is now nearly dry, except here and there pools of water in its deepest hollows, and here the lava goes plunging on, making falls of its red-hot, gory mass where aforetime cool cascades sparkled and rippled. Here we

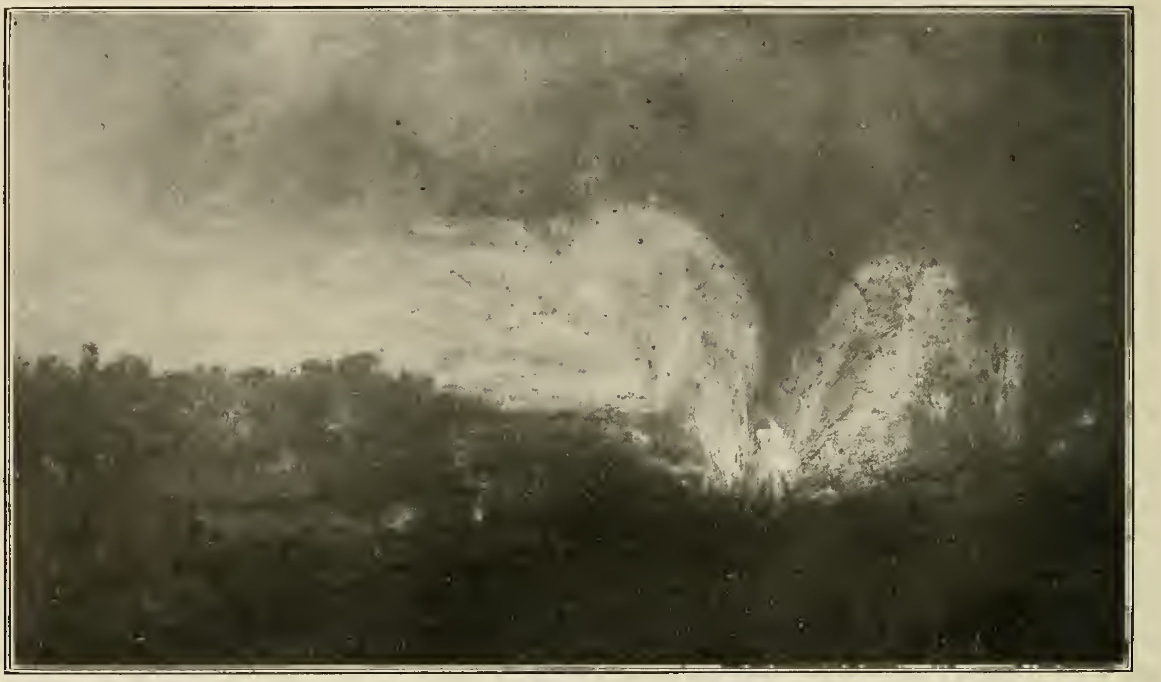


FIG. 90. WATERSPOUT ON THE FLOW OF 1881. FURNEAUX.

found crowds of natives and some foreigners watching the wild scene. We were told that Dr. Wetmore and others were still further on where the main branch was; we had seen only overflows from that which was filling up a still larger channel. A native volunteered to guide us through the bushes and over the great rocks in the way, and we soon had sight of the third party on quite an eminence who called us to hasten and join them, but we had progressed only a few yards when word came that the stream in the narrow gorge was moving on so fast that our return was likely to be cut off, and Mr. Coan, marking its advance by the smoke that rose, felt that it was not wise to attempt to go to the further side. John, whom we had sent on, being fleet of foot, to see how it was, hastened back exclaiming: "Like very much, Mrs. Coan see that!" Meantime the gentlemen, who were already there, took note of the warning and retraced their steps: but Mr. W. offered to assist me to a place where I could see it safely; and what I saw was the most awe-inspiring sight of all, for the mass was far heavier and wider spread, and for speed and fury of motion it was like the rapids of Niagara. But it was all tame to Mr. Coan, who had seen so much more, and tame by comparison to what it must be some miles back, for this is only a picket from the army, and Mr. Coan says it sometimes seems as if it were acting just like military tactics,—this skirmishing on the left wing while the right is holding itself in reserve, and coming down when not watched to bring desolation in the rear. What terrific pouring out of fusion there must be to supply these different streams,—their advanced posts, and to make them so lively so far from the fountain. Why, at night it shows an emblazoned front of four or five miles as estimated. When we went back to the middle one of the three tines of the fork, we tarried long to watch its movements so persistent in pushing by obstacles, checked by nothing, heeding nothing, consuming, destroying, bound for the sea.

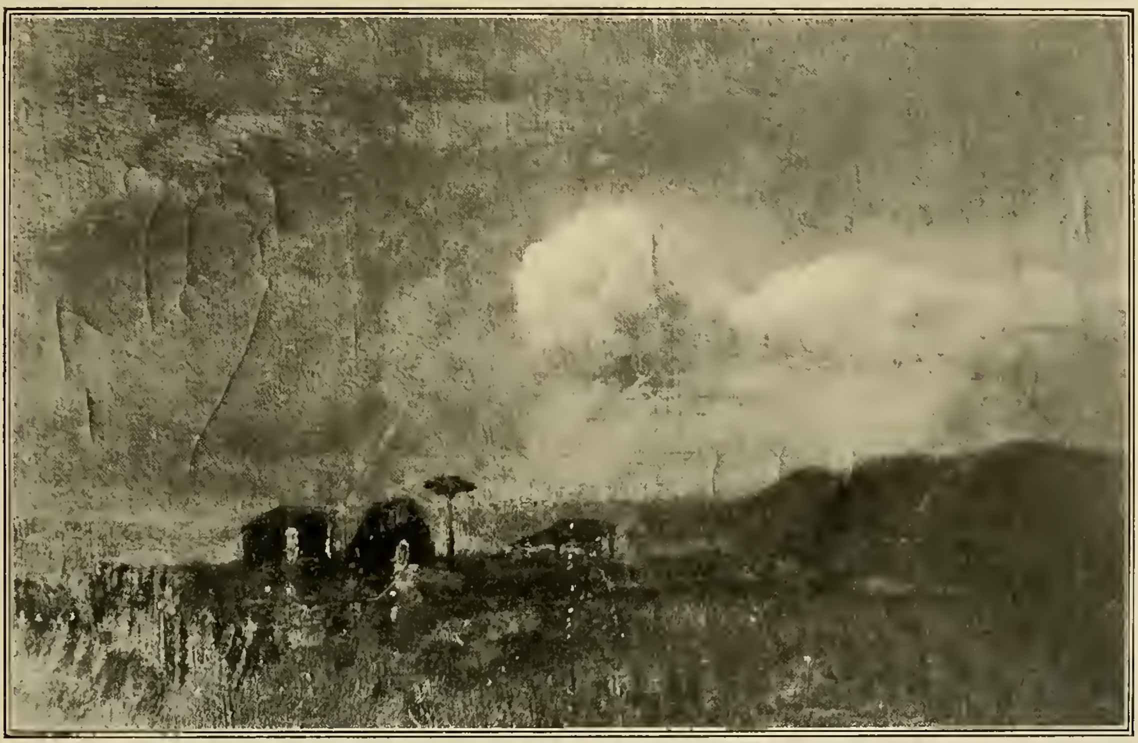


FIG. 91. LAVA FLOW OF 1881 NEAR HILO. FURNEAUX.

Oh! the lovely ferns, one moment waving their fresh fronds in the breeze, the next scorched by the heat, the next a mass of lambent flames, and the next ashes and nothing more. It just makes my heart ache over that. The roar of the lava was something fearful, it was as the roar of a flood. Then the detonations, ten in a minute as timed by the watch, and some of the explosions so heavy we felt the ground tremble under us. John was at one time sitting down in the dry bed of the gorge a little before the lava and nearer it than any one else, when there was a burst of steam through a venthole in the rocks that sent little fragments flying hither and thither, and he was spattered by some of the dirt or mud that came up. Had it been one of the heavier explosions he could hardly have escaped being hurt. While we lingered in the gorge another note of alarm from the natives, to the effect that the flow was approaching the spot where the horses were tied and that soon the road would be cut off, caused us to think well of going ourselves to see how much progress the fire had made in that locality. One of the party called it a false alarm, but then the flow was breaking out here and there so rapidly from over the banks of the channel which it had filled up, no wonder it seemed to some that the danger was everywhere.

It was now noon, and Mr. Coan, wearied, sat to rest on a prostrate trunk, thick green grass under his feet, and verdant boughs of trees above him, but behind him the advancing stream. Here the ground was very level, and of course the flow was not rapid, but foot by foot, yard by yard it rolled forward, and very soon after Mr. Coan had left his seat the burning ruin covered the ground on which his feet had rested and the log was aflame. There was intense fascination in watching all the movements at whatever point we were, and something almost momentarily kept us exclaiming—sometimes it was the quick cooling over the surface forming the corrugated ridges that characterize pahoehoe, and glistening in the sun like perfect bronze—sometimes the puffing of great bubbles that crusted over a moment, then sank back into the fiery bosom from which they had risen —then it rushed down steep places and filling up the hollows from which wreaths of steam curled up, and then its progress through the dense grass, where, for a moment the verdure hung like a canopy over the red serpent gliding under, to melt away and be seen no more. We did not want to come away, and yet how great the mercy that we could come and leave it with the prayer that we might never see it doing greater damage than it was doing. The hours had been full of excitement to me, it was all so much more than I had ever seen before of volcanic displays. I was more weary than I realized when again in the saddle, but the ride home was restful. The air was refreshing after the intense heat, which had burned our faces, and from the point in the road where the view of Hilo, the bay and the greatly indented coast line breaks upon the eye, the prospect before us was perfectly enchanting in its glowing beauty. I have always thought it a view of surpassing loveliness, but now that there is so much more cultivation, and the waste places are emerald rice fields or taro patches, and the Waiakea mill and plantation are seen on the right, the beauty is enhanced. Must the fiery flood leave a line of black desolation through it all? How great the mercy that the track it is now on is one so apart from human habitations, and that there is no danger to human life. Our homes are not to be overwhelmed from this side: that seems plain, and we will still trust that the "hitherto" command has been spoken to the threatener on the right. One breath can quench it as quickly as it kindled it and all our fears abate. A prayer and conference meeting was held that evening at Mr. David Lyman's, and there was comfort in singing the sweet hymns "Father, whate'er of earthly bliss," "How firm a foundation ye saints of the Lord," and "Saviour, like a shepherd lead us;" and I think there was some truth in the saying from the heart "The will of the Lord be done." I wish you could have been there as we were thus carrying this care to the Lord and shared with us the quieting influences of the hour.

I have quoted this letter so fully that my readers, who have not known these people as I have, may recognize the noble souls, trusting and undaunted in the hour of so great peril, who made Hilo what it was, a town of homes.

From the western shore of Hawaii, at Kawaihae, the view of this eruption was very grand. Even in the quietest geological times the early morning approach to Kawaihae on the steamer is very fine with the three mountains of Hawaii lighted by the rising sun. If it be in winter and the snow caps are on Kea and Loa, the rosy glow is worth the journey to see. On the beach the little village is still in shadow of the departing night, and the great temple of Puukohola stands gloomily just beyond the town, but from Kea to Hualalai the glow of the coming day is fast spreading, and the light canoes of the fishermen are nearing the shore. Mr. Furneaux caught all this, and to the grand dome of Loa was added the two fire fountains and the canopy of lurid cloud of this eruption. The photograph cannot give the colors of the original painting which is in the gallery of the Bishop Museum.

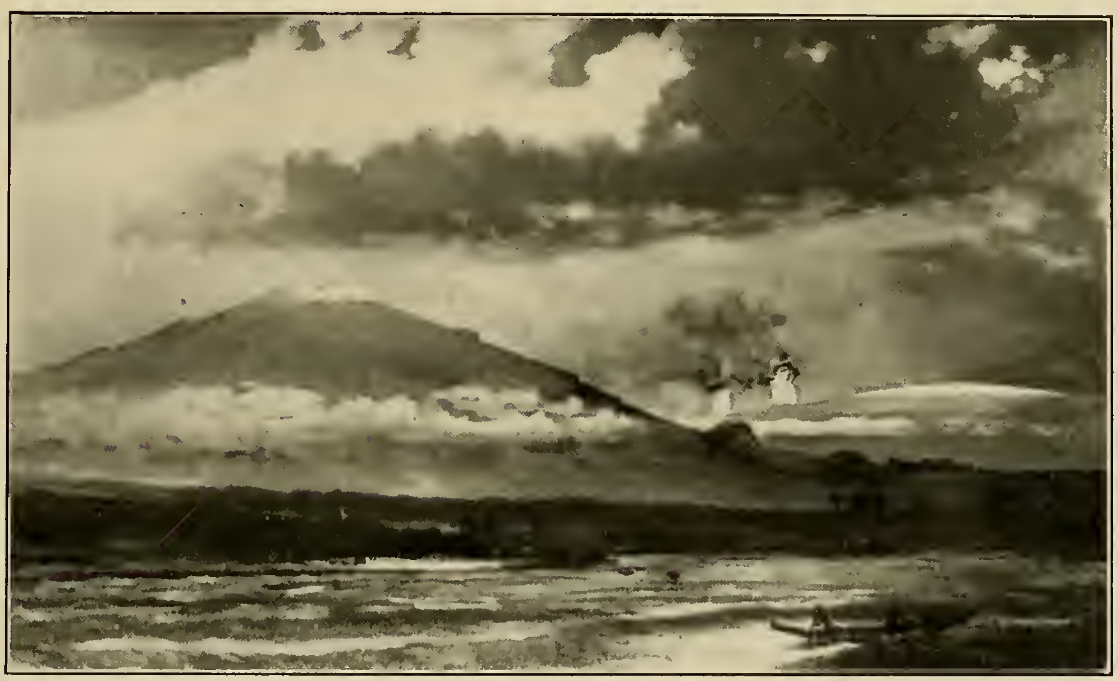


FIG. 92. ERUPTION OF MAUNA LOA SEEN FROM KAWAIHAE BAY. FURNEAUX.

January 17, 1881. Charles Burnham.—After an absence of forty-five years I find the crater [of Kilauea] much changed since 1835. It was then estimated to be eight hundred feet deep over the whole surface. One hundred and ten cones over fifty to seventy-five feet high. There was then a very large lake plainly visible night and day from the volcano shanty.

October 5, 1881. Theo. H. Davies.—The new lake was very active; the bottom edges of the surrounding rock were red-hot and the surface of the lake was always in commotion in some places. I counted nine cauldrons at once where the lava was boiling and splashing, a perfect blood-red, throwing great flakes perhaps twenty feet high. We then went to Halemaumau, but that was not accessible; it seemed to have more jets than the new lake. We went farther to the right and came to a pit of fire; this was hard on the surface but red at the edges.

December 21, 1881. An immense cave of the pali on the west side took place this day at 9 A.M.

July 14, 1882. F. W. Damon.—New Lake and Halemaumau very active. In the former the lava appears to be slowly rising; it was yesterday within thirty or forty feet of the edge where we stood.

July 14, 1882. Capt. C. E. Dutton wrote much in the Register which he probably afterwards revised in his published work on these Islands, so it need not be copied here. He was also here on September 12th of the same year, and found at Mokuaweoweo "no volcanic action whatever, not even a wisp of steam issuing from any part."[113]

September 12, 1882. W. H. Lentz.—The largest flow of lava that has been here at Kilauea for years took place today at 10:20 o'clock A.M. The only effect seemingly on the lakes was to lower their level about ten feet in each.

December 1, 1882. Rev. Titus Coan died at Hilo, aged 81 years.

February 8, 1883. Rev. A. O. Forbes.—Find more action in crater than there was a week ago.

Professor C. H. Hitchcock ascended Mauna Loa in 1883 and found snow all over the summit: no signs of action.[114]

March 30, 1883. H. M. Whitney.—Found Kilauea in its usual condition with occasional overflows of the lakes, and the crater filling up gradually.

August 9, 1883. Prof. Geo. H. Barton [Professor of Geology in Massachusetts Institute of Technology].—Fine display at South Lake. There were three islands in South Lake.

September 1, 1883. Fred H. Allen.—We saw a sight our landlord said he had never seen; the new lake, after a few moments of great quiet, suddenly boiled in nearly every part, and swallowing the black crust glowed fiery red over the entire surface. So hot was it that we had to step back several yards from the spot where people generally sit when looking at the lake, and even then were obliged to screen our faces with our hands. This same evening we noticed one or two large cracks on the surface of the large crater near the lakes that we had not seen the night before.

October 18, 1883. W. E. Shearburn.—During the time that Mr. J. Bryce and myself were here we made three descents into the crater, and on each occasion the two lakes were very active. On the night of the 13th, a large cave took place in Halemaumau, and on the night of the 17th there was a most brilliant break up of the new lake. Mr. Bryce attempted the ascent of Mauna Loa, but was stopped by the mist.

November 1, 1883. Rev. Edw. P. Baker.—Mr. Richardson and party went to the place near the trail from Puna to Kapapala, where, in 1868, the lava appeared on the surface. The lava came out at several points, but the largest space covered by lava is, say, one-eighth of a square mile. The bearing of Kahuku and the land-slide at Kapapala from Kilauea, is to the right (looking from Kilauea) of the direction of the crack and of the lava that came to the surface in 1868 from Kilauea. [On the 2nd Mr. Baker went to the south side of Halemaumau and threw an iron wire (a lava fragment at the end) into the boiling lava. The boiling process continually pulled the wire down, and down, for about three minutes, when the wire was burned off. A south wind compelled Mr. Baker to go round to the south side of Halemaumau.]

March 9, 1884. C. H. Dickey.—We found a new little crater on the route between Halemaumau and the New Lake. The guide says that it began to form last Tuesday, March 3rd. We visited it as we went to Halemaumau and it looked precisely like the furnace of a blacksmith's forge and over two feet across, but while we were watching Halemaumau the little crater burst forth and gave us a distant view of a lava flow several hundred feet in length. We have named it the "Little Beggar," on account of its viciousness.

---

[113] United States Geological Report, iv, p. 139.

[114] The page containing notes of this, as well as of his visit to Kilauea, has been torn out of the register, so that I was not aware of the visit of this distinguished geologist until I saw, long after this account was written, his note in the register complaining of the outrage. I understood that Professor Hitchcock was preparing for the press a work on the geology of the Hawaiian group, and for that reason I have omitted reference to his valuable papers on the subject in the publications of the American Geological Society and elsewhere.

January 15, 1885. Dr. C. H. Wetmore.—The crater in vicinity of Halemaumau appears to me to have been considerably built up since my visit here, 7/2/84.

April 25, 1885. Rev. E. P. Baker.—I ascended Mauna Loa, reaching Mokuaweoweo about 10 A.M. April 20th. Snow covered the upper portion of the summit plateau in large masses, and in small scattering patches extended nearly a thousand feet below the summit. I left behind all clouds at the height of between seven and eight thousand feet, all clear and cold too above that. The wind (very cold) was continuous and in heavy gusts, blowing all the while from S.E., S. and S.W. The walls of Mokuaweoweo, especially the western, were plentifully bedecked with snow, and there was much snow on the floor of the crater. The spot of the Commodore Wilkes encampment was mostly covered with snow, so that I saw as the only relics there, two sticks, a broken bottle and a few nails. To my remark then and there made to J. Ulumahiapua Pea of Panau, Puna, "Wilkes' encampment," his reply was, "My grandfather Ulumahiapua Pea was the guide." We walked up and back from Ainapo. Six full days were spent in travel. The pocket barometer of Mr. Richardson which I carried showed Mauna Loa to be 13,300 feet above sea level. The summit crater was quiescent, just as it has been for several years: however, sulphurous smoke and steam were issuing from cracks in the floor of the crater, the crater being of the shape of the figure 8 written horizontal. I descended into Mokuaweoweo and spent the night by the steam and smoke cracks in the floor, keeping very warm by the issuing heat, although the night before I slept in a cave with icicles over head. Only one who has been there can realize the formidableness of the task of going down and coming up out of the summit crater of Mauna Loa. The angle of descent was 90° in places, and not apparently less than 75° or 80° any of the way. The place where I descended was at a point on the northeast brink, two-thirds of the descent bringing me to the floor of the first bench, and the other third to the lowest bench of the largest part of the crater. The barometer indicated the floor of the

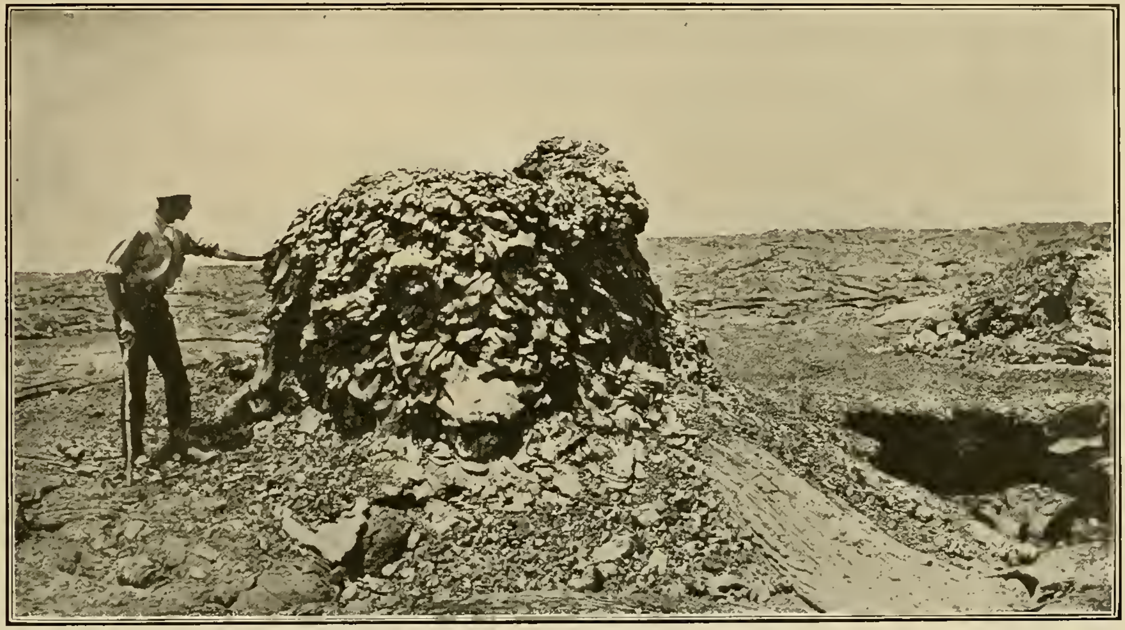


FIG. 93. LITTLE BEGGAR IN 1889.

crater to be only four hundred feet below the brink (the real depth being, however, rather more). It was during most of the time in clear sky above the clouds, it being nearly all the time the jaunt lasted rainy below. My last day on the mountain gave signs of a heavy storm, the upper and cirrus clouds being driven over by the southwest wind, and meeting the trade wind and lower clouds, and looking very angry at the place of meeting. The storm that followed was one of the heaviest ever known on the island. I was fortunate enough to reach a camp for shelter (6000 feet up) a few hours after the storm struck me. I found myself affected with vertigo after awaking from sleep on the floor of the crater on the morning of April 21st.

May 17, 1885. L. A. Thurston.—The flow from Little Beggar, which has been running since early in March, has nearly reached the east wall of the crater.

May 18, 1885. W. R. Castle.—Kilauea: Flowing lava about half a mile to right of point where road meets crater bed. New Lake about twice the size of April, 1882. The change seems to be from caving away of the westerly bank, and towards Halemaumau. The island is all that remains of that bank. South Lake changed by caving away of banks with loss of the crest of high ridge to the northwest...... Witnessed a break up of the surface which floated to the southeast corner and plunged in. Little Beggar and the flow thence to the northeast are wholly new; so is the break down in the surface between this and the south lake.

In October, 1885, Mokuaweoweo was again surveyed, this time by J. M. Alexander for the Government Survey, and a copy of his survey is given on the opposite page. It is interesting to compare the variations in these plans, which certainly were not wholly due to a changing crater. Alexander found the bottom of the crater covered with fresh lava, but no fires visible. Of the two cones shown on the plan the southwestern one was a hundred and forty feet high and still smoking: steam was rising from "hundreds of cracks." In the northern division of the crater was a circular pit crater a thousand feet in diameter and six hundred feet deep, still smoking from a small cone in its centre. At the junction of this northern division with the north terrace of the main crater an eruption had broken out, like that of 1832 in Kilauea, from the rim, and flowed into both compartments of the crater. In 1864, when on the highest part of the walls, I saw such an eruption that had fallen into the main crater from the rim. Many blocks of a "solid, flinty lava," weighing from fifty pounds to a ton, were noticed on the summit about the crater, sometimes a quarter of a mile from the edge of the crater. These were of the clinkstone used by the old Hawaiians for stone adzes and grindstones, and their position has not been satisfactorily explained. But the account by Mr. Alexander in the American Journal gives more completely his observations:

ON THE SUMMIT CRATER IN OCTOBER, 1885, AND ITS SURVEY. BY J. M. ALEXANDER.

American Journal of Science, July, 1888, p. 35.

During the year 1885 I was engaged for many months in surveying lands on Mauna Hualalai and Mauna Loa in Hawaii, and in that way had an opportunity of making investigations of craters and lava-flows that have some interest connected with the study of volcanic phenomena.

On the first of September, 1885, I set out in company with Mr. J. S. Emerson, of the Hawaiian Government Survey, to ascend the mountain from the table land east of Hualalai, along the south

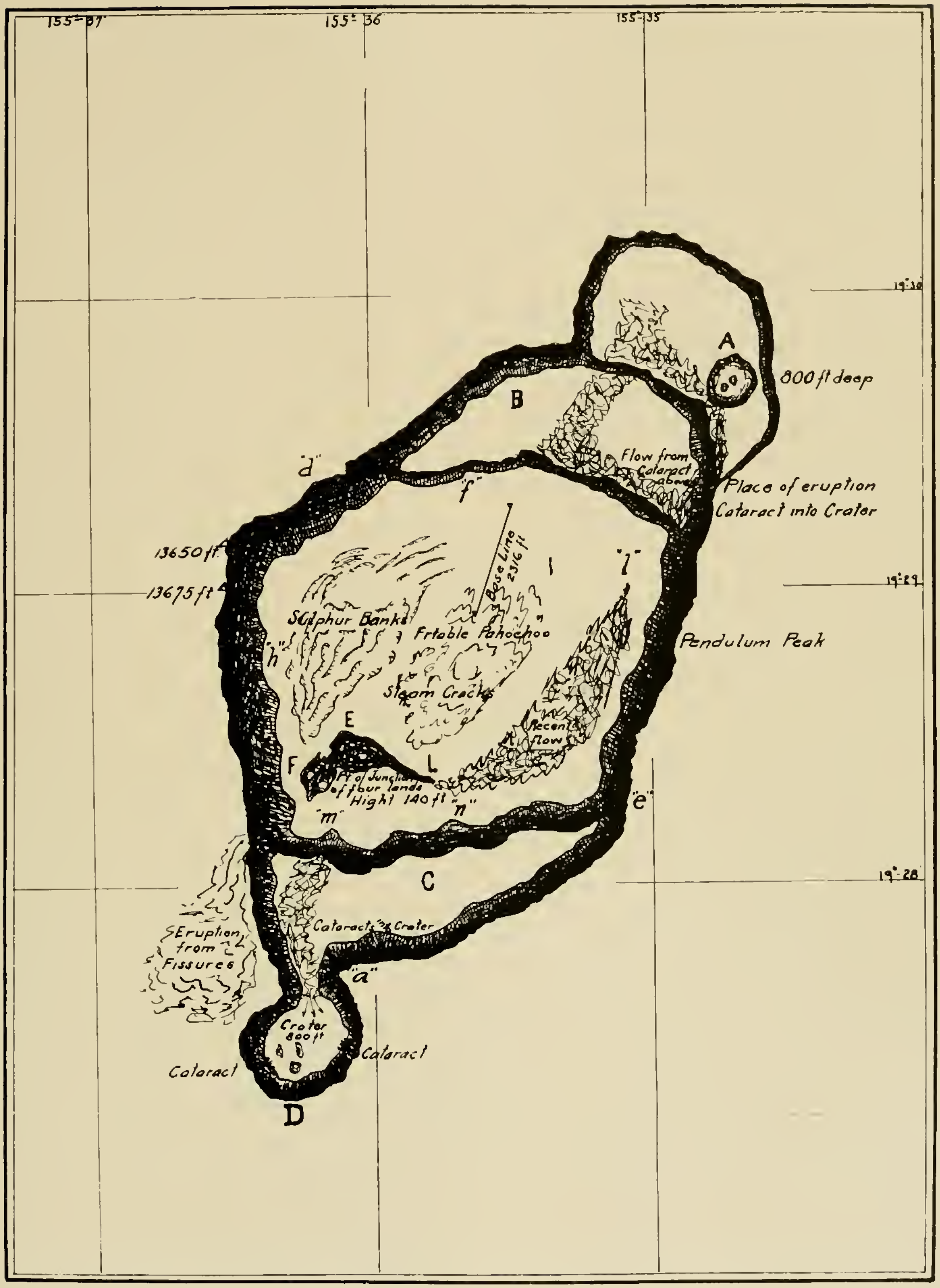

155° 37'
155° 36
155° 35'
19° 30
19° 29
19° 28
A
800 ft deep
B
"d"
"f"
Flow from Cataract above
Place of eruption
Cataract into Crater
13650 ft
13675 ft
Base Line 2316 ft
"l"
Sulphur Banks
Friable Pahoehoe
"h"
Steam Cracks
Pendulum Peak
E
F
L
Recent flow
Pt of Junction of four lands
Hight 140 ft
"m"
"n"
"e"
C
Eruption from Fissures
Cataracts in Crater
"a"
Crater 800 ft
Cataract
Cataract
D

FIG. 94. GOVERNMENT SURVEY OF MOKUAWEOWEO.

side of the lava-flow of 1859. Our route led first through a narrow belt of forest, consisting of mamane, ohia and sandalwood trees; then through a scanty vegetation of ohelos, and the beautiful *Cyathodes Tameiameiæ*, and at last beyond the limits of vegetation, without a vestige of moss or lichen, over a waste of pahoehoe lava, traversed by tracts of aa and deep chasms.

At about two-thirds of the distance towards the summit we passed the rugged crater hill from which the outbreak of 1859 had issued, and here our path was strewed with pumice and "Pele's hair" from that eruption. An enormous quantity of lava was poured forth from the small fissure of this crater, forming a stream from half a mile to two miles wide, and reaching nearly thirty miles to the ocean at Kiholo. Lower down I counted eighteen species of ferns and a dozen kinds of phænogamous plants already growing on this flow.

Reaching the brink of this vast crater, we found that along it were numerous deep fissures filled with ice and water, making ready for avalanches into the crater. Here, and for a quarter of a mile below, we observed many rocks of different kind from the surface lavas, solid, flinty fragments of apparently the foundation walls, weighing from fifty pounds to a ton, which had formerly been hurled out during eruptions. I noticed similar rocks around the summit craters of Hualalai.

At evening the fog lifted and gave us a glimpse into the craters. The central crater [see the plan] was surrounded by almost perpendicular walls, and had a pahoehoe floor streaked with gray sulphur cracks, from hundreds of which there issued columns of steam, and in the south end stood a still smoking cone. South of this central crater there was a high plateau (C), and beyond this high plateau, still farther south, an opening into another crater small and deep (D). In the opposite direction, north of the central crater, appeared another higher crater, like an upper plateau (B) from which a torrent of lava had once poured into the central crater, and north of this again, another crater (A) like a still higher plateau, from which also lava had flowed southward.

Thus it was evident, as appeared more clearly by subsequent investigation, that Mokuaweoweo is not simply one crater, but a series of four or five craters, the walls of which have broken down, so that they have flowed into each other.

We erected a survey signal for determining the location and height of the summit, and also of an important land boundary in the crater, viz: the corner where the four lands of Keauhou, Kahuku, Kapapala and Kaohe met, which is at the cone in the central crater.

During the next month I ascended the mountain again, this time carrying an excellent engineer's transit. In the clear frosty air of the summit station I was able to take the bearings of a dozen survey signals on the slopes and summit of Hualalai. The new spherical signal which I had erected was afterwards accurately determined by observations from more than twenty stations on Mauna Kea, Hualalai and in South Kona, and thus a trigonometrical station was at last located on the very summit of Mauna Loa.

On the second day I descended into the central crater, and found much of the bottom to consist of the most solid kind of pahoehoe; but in some large tracts the pahoehoe was covered with pumice, indicating the violence of the former surging and tossing of the lava. Just before reaching the cone we came to a deeper basin (E) twenty or more feet below the rest of the crater bottom and about 400 feet wide, covered with the most friable lava, swollen upward as if raised by air bubbles, and this basin extended into a lava flow (LL) northeastward along the side of the crater. Probably this was the place of the last eruption and of most of the eruptions of this central crater.[115] The cone, 140 feet high, was composed of pumice and friable lava still hot and smoking. We ascended it and set up a flag there for the boundary corner.

I returned to the second plateau to the north (B), and thence clambered out to the east of Mokuaweoweo by the route of a former cataract of lava from the summit into the crater, the black, shining spray of which lay spattered on the surrounding rocks. Farther south there were the courses of two other cataracts, which had poured directly into the central crater. At the summit I found the deep fissure from which these cataracts had been supplied with lava, and ascertained that it had also poured an immense stream north upon the first plateau and thence into the central crater. Crossing from this place to the north over the first plateau I suddenly came to a circular crater in the bed of the plateau (A), apparently 600 feet deep and a thousand feet wide, with a cone in its centre still smoking. The next day we took the transit to the stations in the crater, and the following surveyed along the western brink to the extreme south end where we looked into the south crater (D), which is about 800 feet deep and 2,500 feet wide. The length of the whole chasm I ascertained to be about 19,000 feet, the greatest breadth 9,000 feet, and the greatest depth 800 feet, and the area three and six-tenths square miles.

---

[115] Mr. Alexander seems to have put too much faith in the permanent character of this cone as a boundary of lands or a source of eruptions. In 1870 it did not exist, and has been succeeded by others, as will be seen later.

On the southwest side, near the junction of the central crater with the south plateau (C), I found that there had been another eruption from fissures that were still smoking, and that this eruption had sent an immense stream southward toward Kahuku, and had also poured cataracts into the south crater from all sides.

I had everywhere observed that there had been great flows from the summit brink down the mountain, and questioned whether the chasm had filled up and overflowed its brim. This, however, turned out to be an incorrect view. The flows have not been from the lowest parts of the brim, but from some of the highest, which could not have been the case in an overflow. The walls of the craters largely consist of loose, old weather-beaten rocks, and large tracts of the plateau are composed of old pahoehoe, that has not been overflowed for ages, which would not be the case if the craters had filled and overflowed.

These outbreaks from fissures around the rim indicate that the lava has rather poured *into* the crater than *out of it;* and that it has flowed from such fissures in vast streams down the mountain side. The question arises, how has the lava risen high enough to pour in extensive eruptions through these fissures, almost a thousand feet above the bottom of the crater, without rising in the crater and overflowing it? The same question has often been asked in respect to the rise of liquid lava to the summit of Mauna Loa without overflowing the open crater of Kilauea, 10,000 feet below.

While surveying the region, I was extremely interested in the arrangement of the craters; and now, having determined the situation of more than fifty of them on Mauna Loa, Hualalai and Mauna Kea, I have ascertained that there is a method in their arrangement. They are not arranged relatively to the mountain on which they are situated, but relatively to the points of the compass. There seems to have been a series of nearly parallel fissures through which these craters have risen in lines running from S. 40° E. to S. 60° E. There are a few arranged in lines running N. 50° E.

It has been remarked by Mr. W. T. Brigham, in his memoir of 1868 on the volcanoes of the Hawaiian Islands, that while the general trend of the Hawaiian group and of the major axis of each island is N. 60° W., there is no crater on the islands whose major axis is parallel to this line. "On the contrary," he continues, "a very interesting parallelism is observed among all the craters, and invariably the longest diameter is north and south." It would be more correct to say that the major axes of the great craters are usually at right angles to the general axes of the group, *i.e.*, about N. 30° E. Haleakala and the ancient Kipahulu crater appear to take the other direction, but the statement is certainly true of the great craters of Kilauea and Mokuaweoweo, which have other points of resemblance. Thus in both the highest walls are on the western side, and in both the action is working toward the southwest, as is indicated by the fact that the northeast craters are nearly filled up, while the deepest and most active craters are in the southwest end of the depression.

To return to Kilauea. There had been little change since 1882; the islands noticed soon after the formation of the New Lake, in 1881, proved to be floating islands (see Plate LXII). On the sixth of March both Halemauman and its overflow,

1886

the New Lake, were running over and on about the same level. On the morning of the seventh, between two and three o'clock, the lava of Halemauman sank out of sight, taking with it the contents of the shallow New Lake. The preceding activity seems to have extended northward, as the sulphur banks near the house had become much hotter, and the hotel bath house over one of the cracks was, on the afternoon of March 6th, too hot to be used. At half-past nine of that evening there was a slight earthquake, and it was followed at an interval of fifteen minutes by three other shocks which made sounds "like the fall of a meal-bag on the floor." During the night there were forty-one slight earthquakes counted at the hotel, but no damage was done, and they were not felt outside the crater region. It was thought at first that the fall of the walls of Halemauman, that is, the cone surrounding it, had caused the vibration, but deep fissures were opened at the same time for a mile along the road to Hilo which certainly could not be attributed to this cause. A notable occurrence was the cessation of the discharge of steam from the cracks in the sulphur bank near the hotel two days after (not at the time of the fall of the lava and walls), but the steam gradually returned after two more days. There is no report as to the temperature of the aqueous vapors at the time of return. No outlet, or rather outflow, of the lava was noticed. The main floating island was stranded in the shallow basin, and from photographs taken in 1887 it would seem to have been a portion of crust, but no sufficient examination was made.

Mr. J. S. Emerson, of the Government Survey, reached the crater on March 24th and remained until April 14th. All this while, he says "no molten lava was anywhere visible in the entire crater. At certain points of easy access a stick could be lighted by thrusting it down a crack so as to bring it in contact with the red-hot rocks beneath; but in general there was scarcely a place from which I was prevented access on account of the heat." I quote from Dana the abstract of his report given on page 101:[116]

> The total depth below the datum at the Volcano House to the bottom of the basin of Hale-ma'auma'u was found to be nine hundred feet, and below the rim of the basin about five hundred and ninety feet.
>
> On the twenty-ninth of March he descended into the pit: only Rev. E. P. Baker had preceded him. The sides were covered, not by small fragments of lava, or gravel, or scoria, but by great irregular slabs of the smooth-surfaced lava (pahoehoe), six to eight or more feet long, five or six feet wide, and about a foot thick, and mostly so placed as to slope downward, though many were tilted in all directions; they looked as if ready to slip to the bottom. But at a depth of about three hundred and twenty-five feet, or two hundred and seventy-five feet from the bottom, where the diameter was about six hundred feet, this rough flooring of pahoehoe slabs came abruptly to an end, and a nearly circular pit began, which had the form nearly of an inverted cone......The lower

---

[116] Characteristics of Volcanoes.

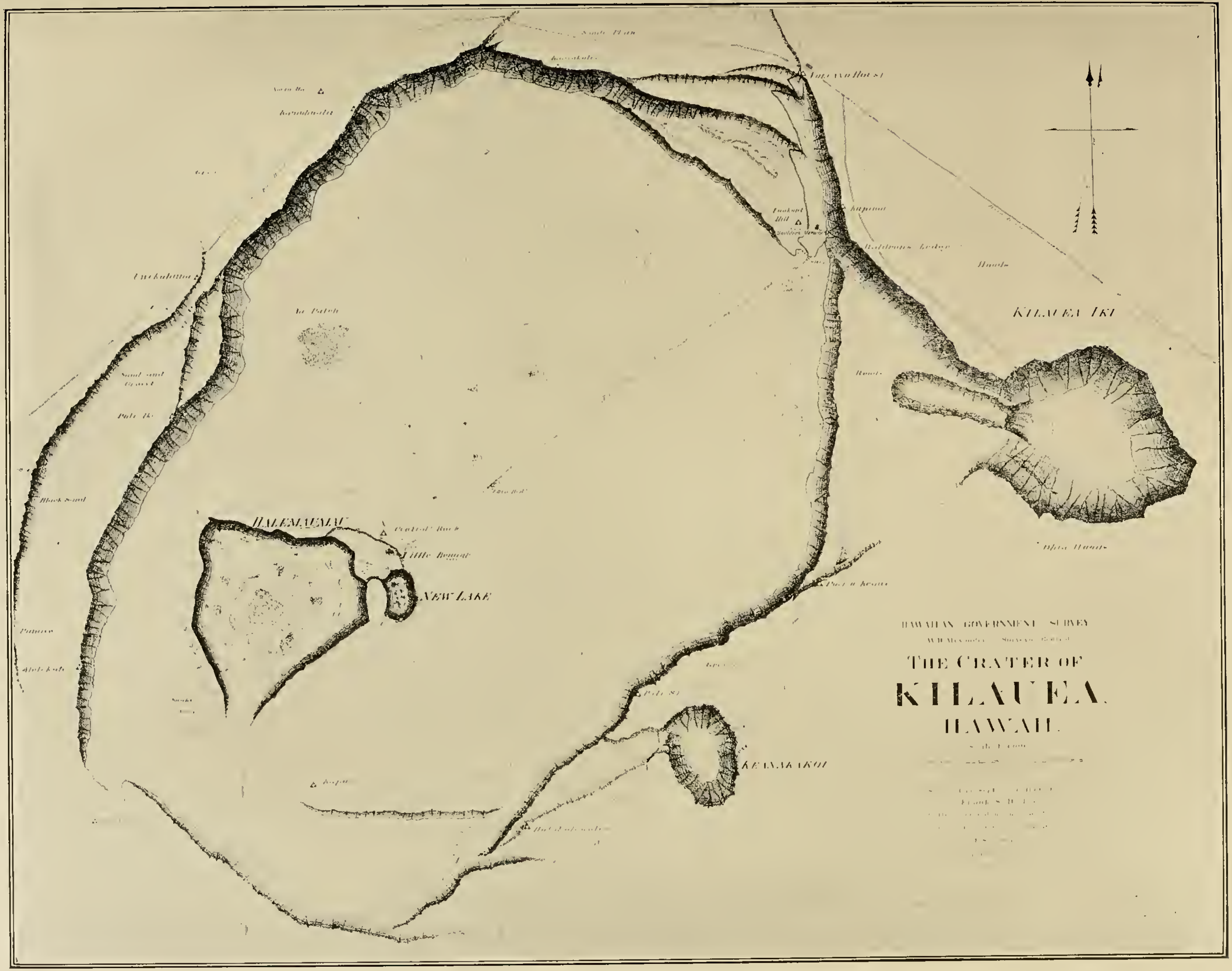

KILAUEA IKI
Lookout Hill
Waldrons Ledge
Uwekahuna
Sand and Gravel
Black Sand
HALEMAUMAU
Little Beggar
NEW LAKE
KEANAKAKOI
HAWAIIAN GOVERNMENT SURVEY
THE CRATER OF
KILAUEA,
HAWAII.

FIG. 95. HALEMAUMAU AFTER THE ERUPTION OF MARCH, 1886.

> basin had an even, lustreless surface, free from large blocks and notable fissures, and consisted chiefly of coarse gravel or fragments of lava, but at bottom of smooth black pahoehoe, free from debris, and of somewhat triangular shape, with sides of twenty-five feet. From a small fissure issued a faintly bluish vapor.
>
> In the upper part of the basin, on the northwest side, about three hundred and sixty-four feet above the bottom and two hundred and twenty-five feet below the top, there was a continuous jet of steam from an oval aperture of five to ten feet. This continued to increase, and on the twelfth of April deposits of sulphur were found about it.
>
> Within the basins of New Lake and Little Beggar there were hillocks of smooth-fissured lava, without debris. The huge bulk of the "Floating Island"......on measurement proved to be sixty feet high and fully a hundred feet in length. The walls of the emptied basin of New Lake were for the most part nearly vertical, and were everywhere covered with a black, vitreous enamel [similar to that covering the interior of the tunnels in the flow of 1881, Little Beggar, etc.].

Professor L. L. Van Slyke of Oahu College was at the crater on July 19th, and found great change in Halemaumau. Not only had the lava returned, but the midst of the depression was occupied by a steep cone of loose blocks of lava rising about a hundred and forty feet high, and from four hundred to a thousand feet from the precipitous wall of the pit on the north side, and this cone was surrounded by a lake of lava covering some five acres. This must have been covered with hardened crust, for Professor Van Slyke ascended the cone and he says:

> I came to the edge of a deep hole or well, of rather irregular outline, four-sided, perhaps thirty or forty feet wide, and from sixty to seventy-five feet long, and not less than a hundred feet deep. The mouth was surrounded by masses of loose rocks, rendering approach to the edge impossible or very dangerous, except at one point; from this point I could see the bottom of the well, and that it was covered with hardened fresh pahoehoe. At one side the liquid lava could be seen as it was puffed out of a small hole every few seconds and thrown up a few feet. The puffing noise accompanying the ejection of the lava was quite like that of a railway locomotive, though louder. The aperture through which the lava was thrown out might have been three feet long and two feet wide. Immediately below the point where I was standing there seemed to be a constant and tremendous commotion, attended by a peculiar swashing noise, but I could not lean sufficiently far over with safety to see anything. Fumes of sulphur dioxide were coming up in abundance, but being on the windward side I was not greatly annoyed by them.

He again went up the cone, but now from the southeastern side: he continues:

> This led to a second well or deep hole, where molten lava was visible. This well was nearly round, with a diameter of perhaps twenty or thirty feet, and a depth of about a hundred feet. At one point the edge could be safely approached; but as it was on the leeward side the fumes of sulphur dioxide could be endured only for a few seconds at a time. Like the other well, the sides were perpendicular. At the bottom was a cone having an opening at the top perhaps ten feet across; and inside liquid lava was boiling with intense violence, every few seconds throwing up a jet of lava, the spray of which came to the mouth of the well almost into my face. The drops of lava thrown to the mouth of the well had cooled enough to become hardened and black when they reached the level on which I was standing. This place was quite noisy, the noise resembling that of violently swashing waters.

Mauna Loa in Eruption.—As in the eruption of 1867 this eruption, coming twenty years later, was ushered in with seismic disturbances. It was not the usual "beacon light" on the summit that was the sole precursor of the outpouring of lava. All through the previous December earthquakes had shaken all the southwestern portion of Hawaii without doing any damage of importance. They, however, **1887** constantly increased in frequency and force and averaged three a day by the twelfth of January. At Kahuku Mr. George Jones counted three hundred and fourteen shocks between 2:12 A.M. of January 17th and 4 A.M. of the 18th; sixty-seven between that time and midnight, and three the following day, or three hundred and eighty-three in all. In Hilea, ten miles west of Kahuku, Mr. Charles N. Spencer reported six hundred and eighteen shocks between 2 A.M. of the 16th and 7 A.M. of the 18th.

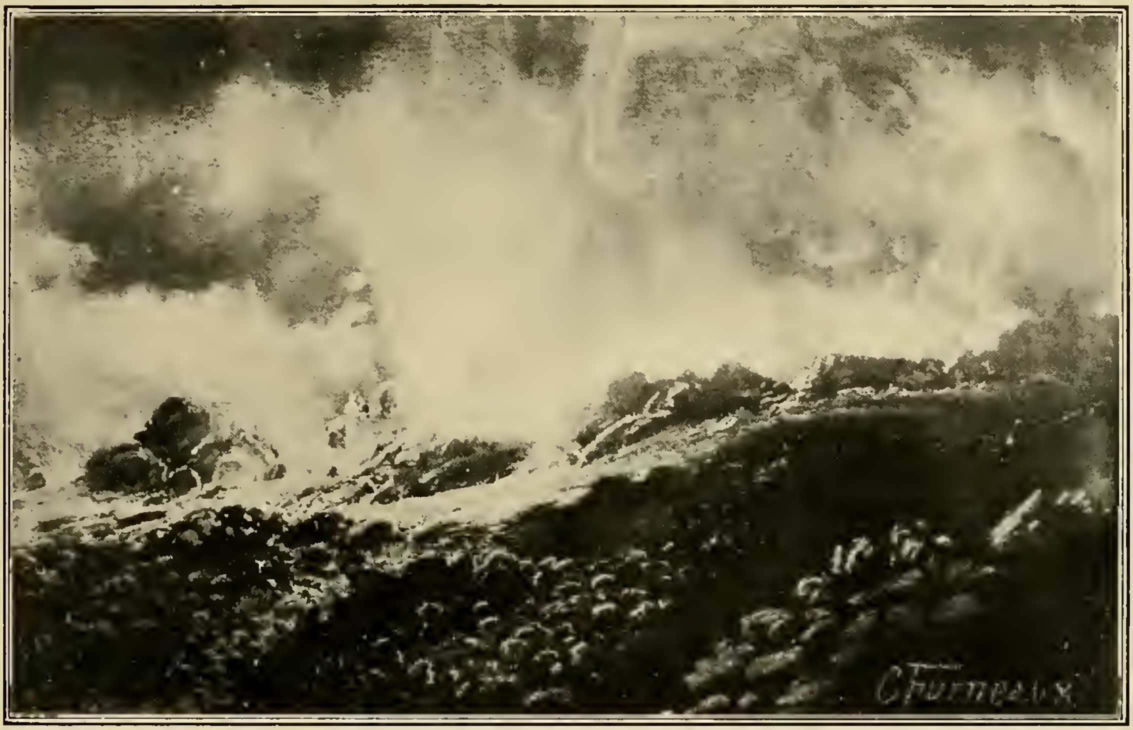


FIG. 96. SOURCE OF THE ERUPTION OF 1887. FURNEAUX.

With this great number of earthquakes, lava at last broke out on the summit of Mauna Loa, three or four miles northeast from Mokuaweoweo, near the lateral cone Pohaku o Hanalei (see note on p. 143), on the night of the 16th, but this discharge ceased after a few hours. It is noteworthy that this outbreak was on the side of the great summit crater most distant from the region of seismic disturbance and where the eruption finally broke out.

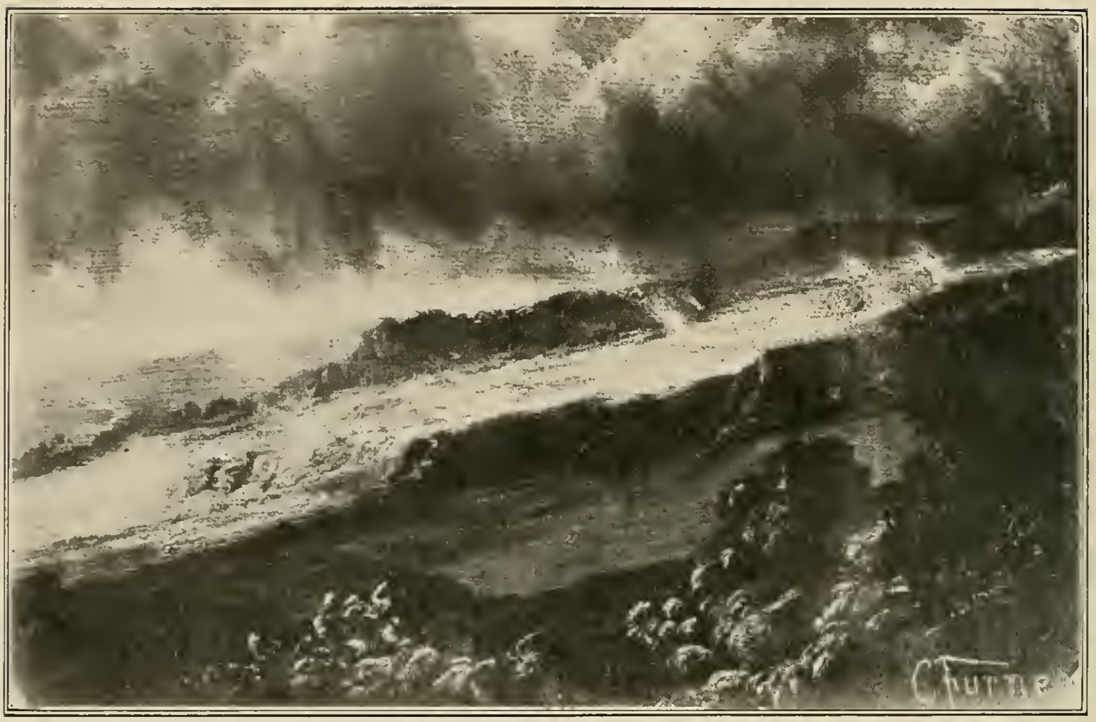


FIG. 97. COURSE OF THE FLOW OF 1887. FURNEAUX.

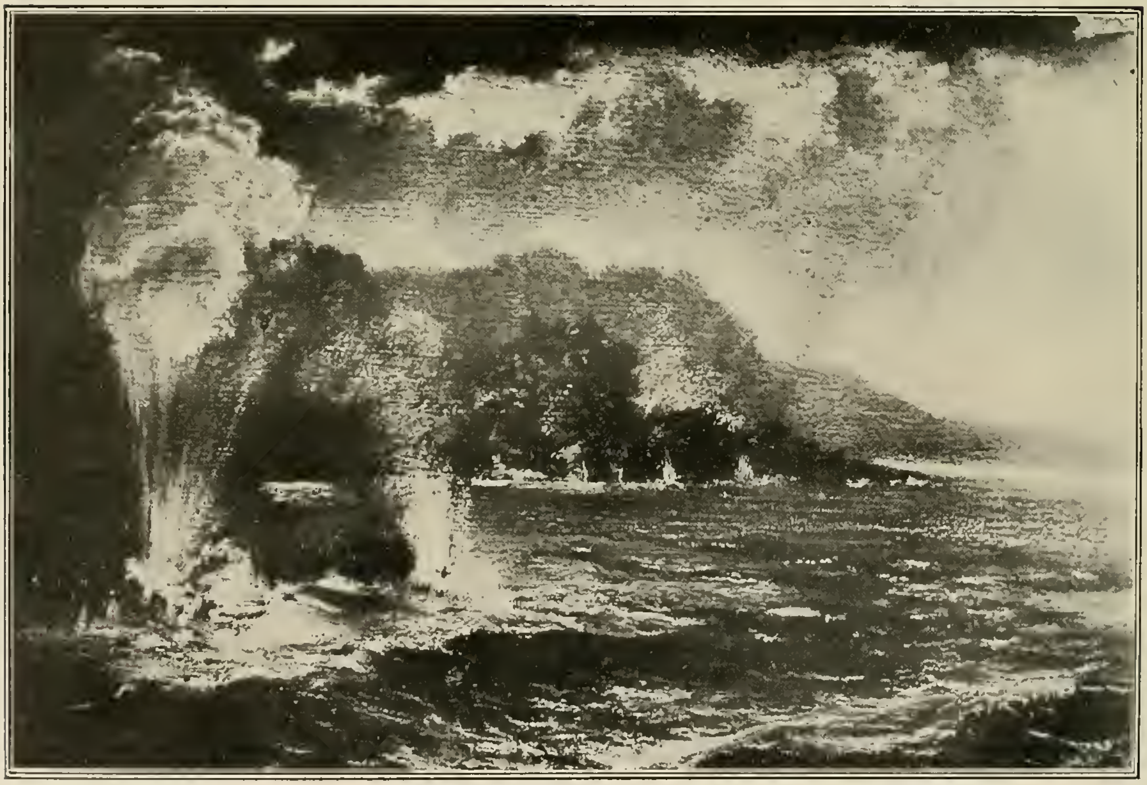


FIG. 98. WHERE THE FLOW OF 1887 ENTERED THE SEA. FURNEAUX.

There is some contradiction as to the exact time that the lava came to the surface in Kau from a fissure about six thousand five hundred feet above the sea, but it was observed early in the morning of the 18th. Mr. Spencer, who visited the most active source on the 20th, says that there were fifteen fountains of molten lava, the highest estimated at two hundred feet. Rocks weighing tons were thrown up or borne along the stream, and while the flow was slow the first twenty-four hours, the formation being mostly aa and clinkers, and explosions occurred at intervals sending up columns of smoke five hundred feet high. Fortunately Mr. Furneaux was on hand and painted the scene from which the illustration is made. Many photographs were taken, two of which are given by Dana, but they fail to give an impression of the outflow at all satisfactory. They might represent a dead lava bed as well. I feel that the three views made by Furneaux show more completely than any pictures I have seen, the beginning, course and end of an Hawaiian lava flow: even without the color, as we have them here, they show better the sublimity of the scene. While the rate of progress at first was only a mile and a half an hour, when the lava moved as pahoehoe its course was rapid, and on the 29th it reached the sea, after a course of twenty miles, nearly four miles west of the flow of 1868, adding another very disagreeable interruption to the many that cross the government road west of the south cape Ka Lae.

Mr. Furneaux again caught the stream as it flowed rapidly between the walls it made for itself where the slope was considerable and the ground fairly clear. The beauty of the green herbage in the foreground contrasting with the black walls within which this Phlegethon rushed with almost the liquidity of water, canopied by the murky pall above, removes the terror a volcanic eruption awakes in many minds when impressions are caught from those spasmodic outbursts in thickly peopled lands where the loss of life and property adds horror to the thought. Here little damage was done, the beauty and variety of the display will never be forgotten by those fortunate enough to see the flow of 1887.

By noon of the 24th the flow had nearly stopped, after extending the shores from three to five hundred feet, according to Dr. S. E. Bishop, who was in this region on the second of February. As the shore was not abrupt the flow built up no mounds of black sand or ash, and the scene as viewed from a steamer off shore was simply a clear struggle between fire and water for possession of the shore line.

Earthquakes were renewed on the 23rd, the day before the flow ceased, and continued on the 24th. These threw down walls that had a northeast and southwest direction—the walls falling to the southeast—and moved light wooden houses eight or ten inches on a slope in the same direction. Slight damage was done in Kahuku, and even in Hilo, where there was a heavy shock felt near noon on the 23rd. The oscillations are reported as from south-southeast to north-northwest. A heavy cloud of smoke was resting on Mauna Loa all Sunday and Monday, January 23rd and 24th, and on the 25th the sun was almost obscured by the smoky atmosphere; on the afternoon of that day a heavy storm of thunder and rain set in. On February 20th Judge D. H. Hitchcock was on the summit and found the crater quiet, but vapors arising from large fissures.[117] According to Rev. E. P. Baker,[118] the fissure about four hundred feet above the point of outflow was still giving out vapors in July, 1888. No deep crater marked the place of discharge.

February 1, 1887. Rev. Sereno E. Bishop, D.D., in describing (Hawaiian Gazette) the lava ridges left when the flow had nearly ceased, says: "The whole seemed like a colossal embankment, as if ten thousand cyclopean trains of mastodon cars had been dumping the rocks of Mauna Loa for a century towards the sea."

December 29, 1887. Mr. J. S. Emerson writes from Kohala, Hawaii, that the view from that place indicates activity in Mokuaweoweo. "Volumes of smoke and steam have been pouring out of the summit crater, but no glow or reflection of fire has been observed......The summit is heavily coated with snow." On March 29, 1888, signs of activity had disappeared. To return to Kilauea:

August 18, 1887. S. D. Fuller.—"A whitish flame visible about edge at five different points." On the 22nd he adds: "Since my last visit the lake had overflowed a space 250×300 feet. Lava in lake had fallen about six feet. Great activity at two points. A bluish flame observed at four points, two being in middle of lake for a short time. A river of lava flowed into the lake from under high central cone."

January 11, 1888. Rev. E. P. Baker.—"Dana Lake quite active." Fell several feet in a short time.

April 8, 1888. Dr. C. H. Wetmore.—"A beautiful fiery fountain."

July, 1888. W. C. Merritt.—From an abstract of the letter of Mr. Merritt, then President of Oahu College, to Prof. Dana[119] (the original not having been published) we find that Mr. Merritt reached the summit of Mauna Loa at noon of the eighteenth of last July, and encamped near the southeast angle of the crater. The spot was considerably lower than the highest point on the west side of the crater, and probably about 13,400 feet above tide-level. Water boiled at 185° F. between 7 and 8 in the morning, when the temperature was at 56° F. The thermometer was at 62° F. at noon, 40° F. at 7 P.M., 30° F. at 11 P.M., and 26° F. at daybreak, so that during the night water froze in a large crack, ten feet below the surface. About half a mile south by west from the southern end of the crater of Mokuaweoweo there was a small but deep pit-crater. Having descended the east wall of the central pit of Mokuaweoweo to its bottom, a small cinder cone was found not far from the eastern wall; and just southwest, a pumice [limu] cone in the midst of an aa flow, the summit of which was very hot and reddish from the action of vapors. In the southwest corner of the pit, there was a cone at F [see map on p. 159], from which vapors were escaping, and south of it, at *m*, a circular pit between 300 and 400 feet in diameter, by estimate, and 150 to 175 feet deep. The walls of the pit consisted of the edges of layers of basaltic rock, one of which was 40 to 50 feet thick, and vertically columnar in structure. The floor of the central pit had, as a whole, a slope from the southwest to the northeast, confirming the view that the southwest part of the pit had been the seat of greatest activity, as it is in Kilauea. Southwest of *m*, the outer wall of the central pit was cut through from top to bottom by two parallel fissures, which had a S.S.W. direction, and thence pointed nearly toward the place of chief eruption of 1887. East of *m* and near the wall in the direction of L, there were great numbers of small fumaroles, from which sulphur vapors were escaping freely, and large deposits of sulphur had been made about them. Near *h* two dikes, 2 to 2½ feet thick, intersected the walls, crossing one another at a small angle, the rock of which had a feldspathic aspect.

---

[117] American Journal of Science, 1887, xxxiii, 310.

[118] Ibid, 1889, xxxvii, 53.

[119] Ibid, 1889, xxxvii, 51.

From a rough measurement, the depth of the crater on the east side was made not over 350 feet. If this small depth is sustained by careful observations, a great change of level had taken place since the survey of Mr. Alexander in 1885. Such a change might have been among the effects of the eruption of February, 1887.

President Merritt also visited Kilauea on July 14th. His letter speaks of the walls of "Halema'uma'u" as, in part, wholly obliterated, as represented by Mr. Dodge: it was fifteen to twenty feet high in some places. The nearly circular lake on the west side of the cone [see plan on p. 170], which he calls "Dana Lake", was in ebullition, but not more active than in August, 1887. The enclosing walls of this small lake were ten to fifteen feet high above the liquid lava within, and fifteen to twenty feet above the floor outside.

Mr. Merritt accompanied the Rev. E. P. Baker, whose notes are of value from his frequent visits to these scenes; they are published in the Journal containing the preceding account; from that source we gather the following: "A descent was made into the southern crater of Mokuaweoweo—probably the first ever made—and the depth found to be seventy-five feet greater than that of the central crater. A fresh-looking lava stream descended into it down the northern wall, which may have been made in 1887."

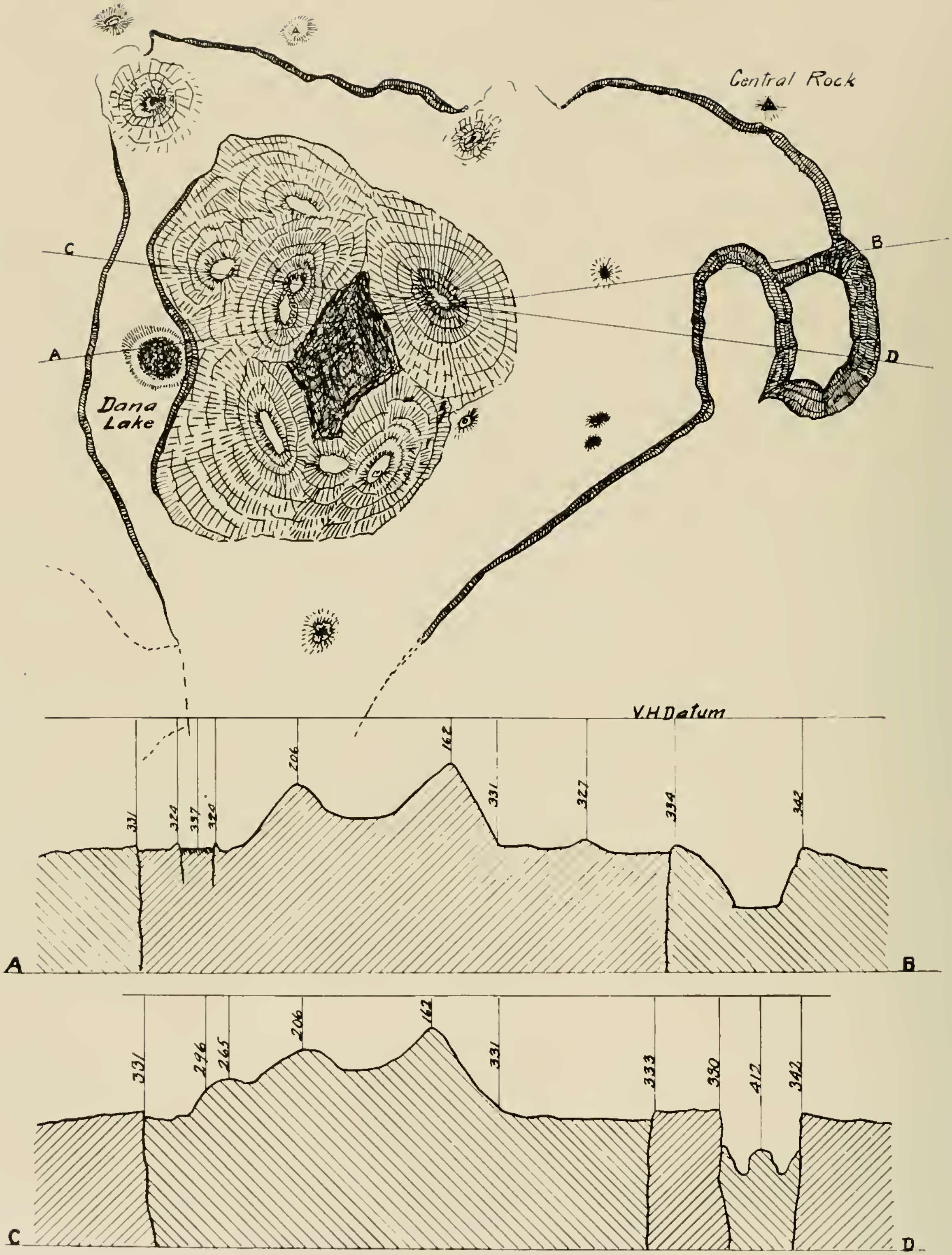

Central Rock
C
B
A
D
Dana Lake
V.H.Datum
331
320
337
320
206
162
331
327
334
342
A
B
331
296
265
206
162
331
333
330
412
342
C
D

FIG. 99. HALEMAUMAU. SURVEY OF JULY, 1888.

Mr. Baker, speaking of the source of the lava streams of the great eruption of 1880–1881, states that:

> The two streams from the source, the Kau or southern, and the Hilo or eastern, originated together at the extremity of a long fissure. This fissure follows the course of a "divide," so that a small obstacle was sufficient to turn the flow to one side or the other. The outflow took place on this divide; a northern stream flowed first, then the Kau stream, and then the Hilo. The fissure ran by the north side of Red Hill, a cone with a deep crater which is still giving out vapors, and this hill was apparently the occasion of the turn off southward of the Kau stream, it standing at the point of their divergence.[120] Water boiled near this hill at 196° F. This Kau stream is in general aa, but near the source it is pahoehoe. At the upper extremity of the fissure there is a pit crater, Pukauahi, which is described as the source of the lavas and is still smoking. At this place also water boiled at 196° F.
>
> On the route from Ainapo to the source of the outflow of 1852, the lavas of the 1852 stream, where they were first reached, were of the aa kind; but after a while there was a change to pahoehoe, and soon after this the source was reached—a red cone in the midst of an extensive bed of pumice. Long ditches or trenches occur in the surface of the region which were evidently the beds of lava streams, their sides having been the banks.[121] The flow appears to have had a single outlet. Water boiled at the source at 200° F.
>
> Going from Ainapo to the source of the eruption of 1887, in Kahuku, about 6000 feet above the sea-level, Mr. Baker passed through regions of woods and grass and saw seven running streams and three or four ponds of water. There had been heavy rains. No deep crater marked the place of discharge.
>
> Over the wide region between Mt. Loa and Mt. Hualalai it is hard to tell where the slope of one ends and that of the other begins. [I have already made the same statement regarding the appearance from the other side.] The 1859 flow of Mt. Loa as it came down heading northwestward, turned just enough northward to fetch by the northeastern flank of Hualalai.
>
> The *Kau Desert*, lying to the south and southwest of Kilauea, has a surface of whitish or light colored sand with areas of pahoehoe lava, which is decomposing in places into a reddish soil. It is about eight miles by six in area. It is destitute of vegetation and owes its dryness to its being under the lee of Kilauea.

To return to the Volcano House record:

> *August 20, 1888.* Earthquake at 7:30 A.M.
>
> *November 8, 1888.* Earthquake at 5:50 P.M. Quite a sharp shock felt all over Hawaii and to Honolulu, according to Mr. H. M. Whitney.
>
> *December 1, 1888.* H. M. Whitney.—Found Dana Lake and Little Elephant cone which is three hundred yards north of the lake, very active. The South Lake has disappeared altogether, the crater is filled up with rocks and no signs of a pit or of fire remain in it. A flow of aa ran for four days in Kilauea, according to L. A. Thurston.
>
> *December 22, 1888.* L. A. Thurston.—There are now two sluggish pahoehoe flows running across the path to the Elephant; and on the south and west there are several flows still very hot. There are about a dozen blow-holes in action besides the lake. There is very intense action in the lake, the surface of which is twenty-five to thirty feet above the general surface of the crater south of it, with a confining wall built by itself of only about five feet in thickness at the level of the liquid lava on the southwest side; and a thickness of not more than ten feet at a point ten feet below

---

[120] It seems rather to have been formed by the flow.

[121] See Furneaux' painting of the eruption of 1887, Fig. 97.

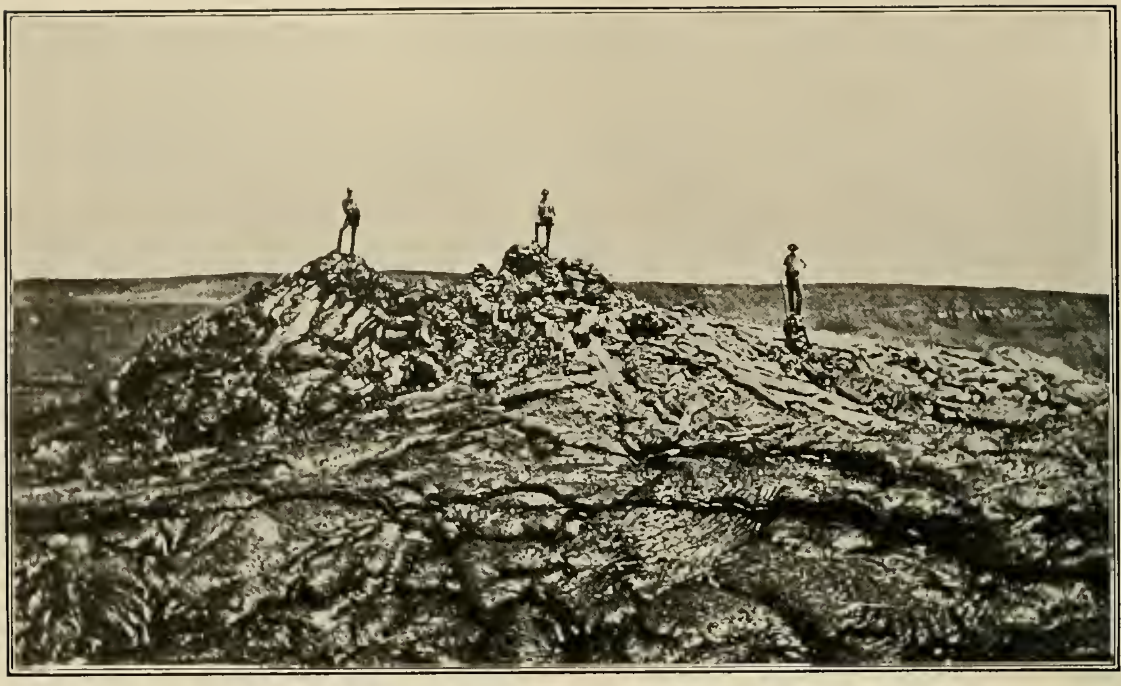


FIG. 100. SPATTER CONE IN KILAUEA, 1889.

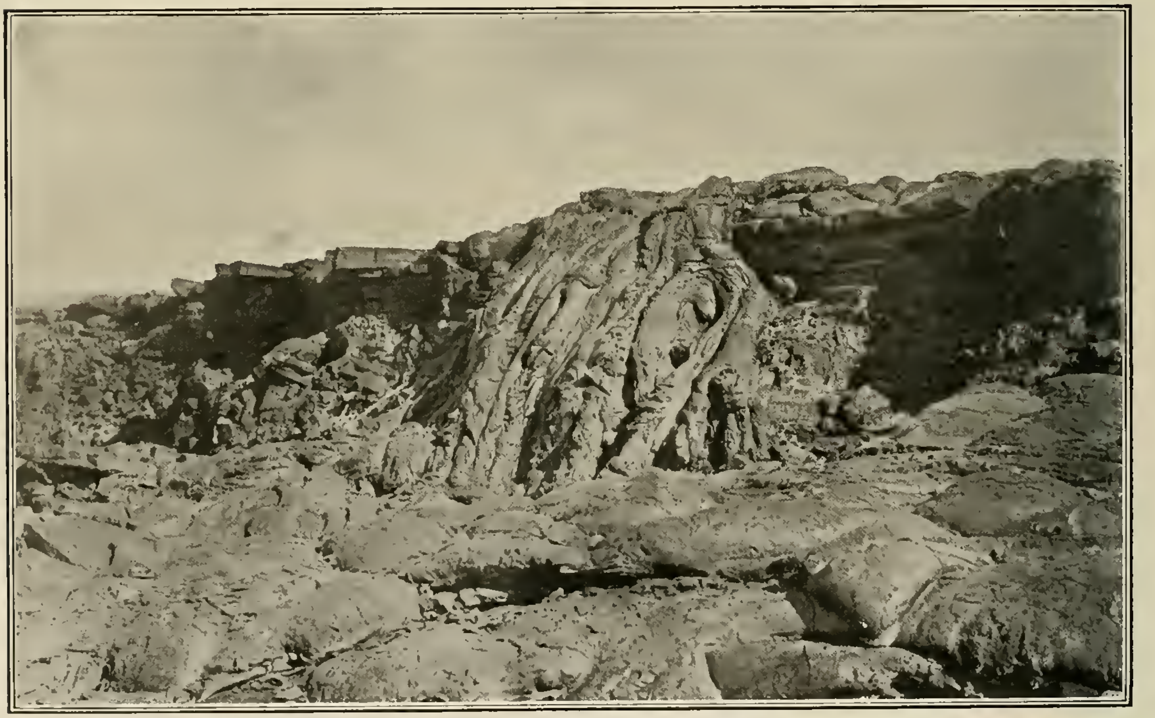


FIG. 101. LAVA FALL IN DEPRESSION NORTH OF HALEMAUMAU.

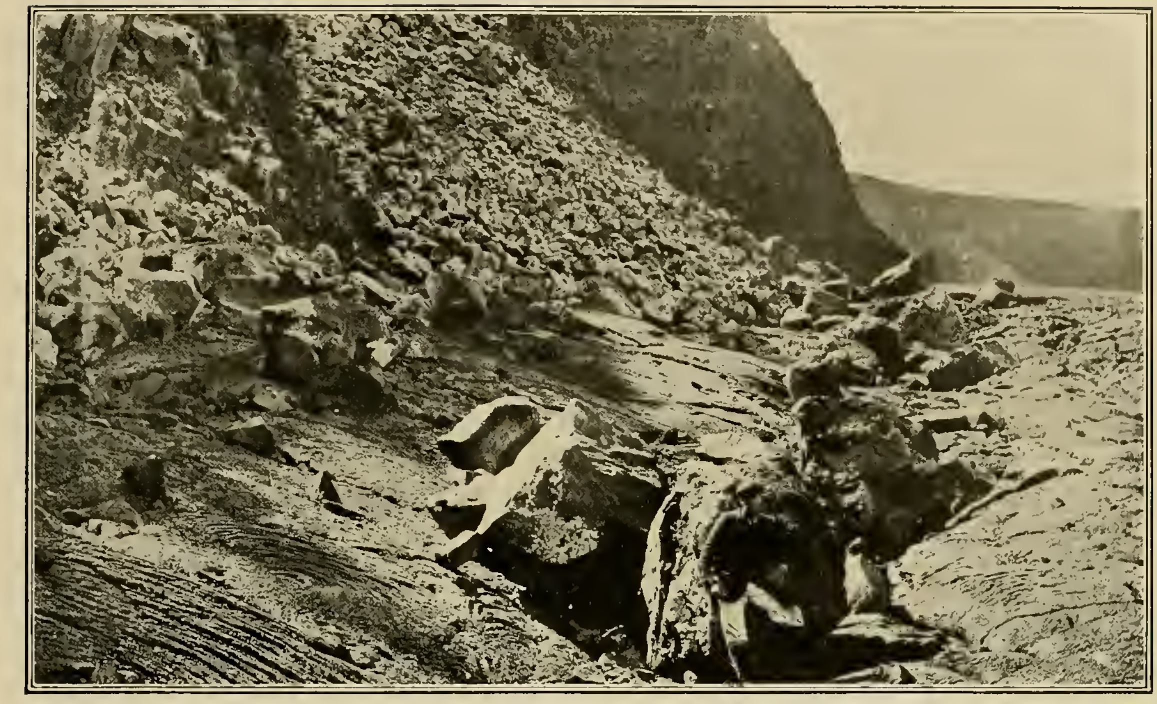


FIG. 102. DEBRIS AND TALUS UNDER EAST WALL OF KILAUEA.

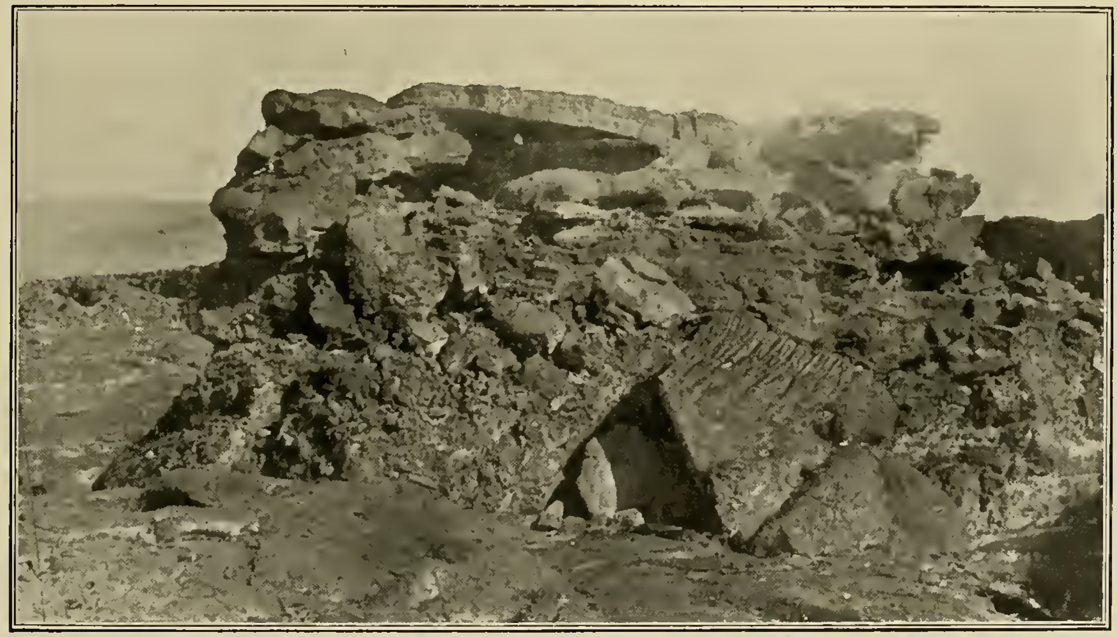


FIG. 103. PILE OF CRUSTS NORTH OF HALEMAUMAU, 1890.

the surface. The surface of the lava rose and fell several times a distance of three to four feet. The Pele's hair on the cliffs and adjacent flat south of the lake is about four inches deep, forming a perfect carpet which entirely conceals the rocks.

March 18, 1889. J. Austin.—Saw "Little Elephant" boiling, and "Dana Lake" spouting in fountains.

January 2, 1890. Rev. E. P. Baker.—The volcano is much as it has been since about the 4th November, '89, when a huge crack was formed in the floor of the crater (northwest-southeast) . . . The formation of this crack was accompanied with a slight sinking of a portion of the central area near the lake.

January 28, 1890. Acland Wansey and W. T. Brigham were at the crater photographing and taking notes.

July 18, 1890. Acland Wansey, W. B. Clark and W. T. Brigham were again at the crater, and many of the illustrations of this paper were then made. Of this party Mr. Clark joined a party for the ascent of Mauna Loa, an expedition which Mr. L. A. Thurston thus describes in the register:

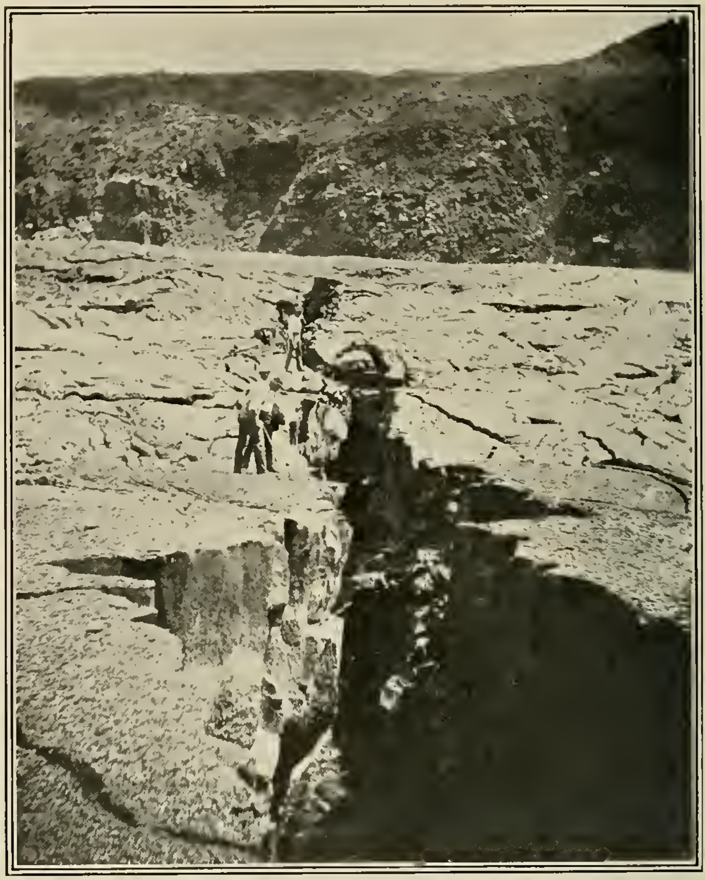


FIG. 104. CRACK IN BED OF KILAUEA.

Memo of an ascent of Mauna Loa by W. B. Clark, of Boston, Julian Monsarrat, W. Gates and L. A. Thurston, under the guidance of Kanae of Ainapo. The time which was occupied in proceeding from one point to another is given for the information of those who may desire to ascend the mountain hereafter as a basis of estimate. Left Kapapala ranch at 5:45 A.M., July 26; arrived at Ainapo 8:30; left at 9 A.M.; arrived at upper water-hole 11 A.M.; at Camp Kakina, at the upper edge of vegetation, 1:30 P.M. Temperature at this camp, where the night was spent, was as follows, in the shade:

1:30 P.M., 58° F.
5: P.M., 54°
6:15 P.M., 52°
6:40 P.M., 49°
6:46 P.M., 48° F.
6:56 P.M., 47°
7:25 P.M., 46° Ditto up to 10 P.M.
4:30 A.M., 43°

July 27 left camp at 6:30 A.M. and arrived at the crater at 11:30. Temperature at noon in the shade, 49°; in the sun, 54°; at 5 A.M. on the 28th, 24° out of doors and 28° in the tent. The entire party, except Mr. Clark, were affected with mountain sickness. Descent into the crater was made by Mr. Clark and myself at the highest point of the cliff on this side, near the old Wilkes camp, where there is a breakdown and a debris pile.

There was very good walking on the floor of the crater, the pahoehoe being unusually smooth. There was evidence of recent eruption from a blow-hole about the centre of the crater which was still uncomfortably warm. The eruption was mostly of a dark pumice stone and a very thin black pahoehoe.

There was steam and some smoke from a spot several hundred yards out into the crater from the western bank. At the southwestern corner of the crater a dense column of steam was rising which did not become dissipated for several hundred feet above the rim of the crater. The spot from which the steam issued was covered with very bright yellow sulphur extending nearly all the way up the crater, and about two hundred feet wide. Immediately at the base of this sulphur bank there was a breakdown in the floor of the crater some one hundred feet deep and several hundred feet across.

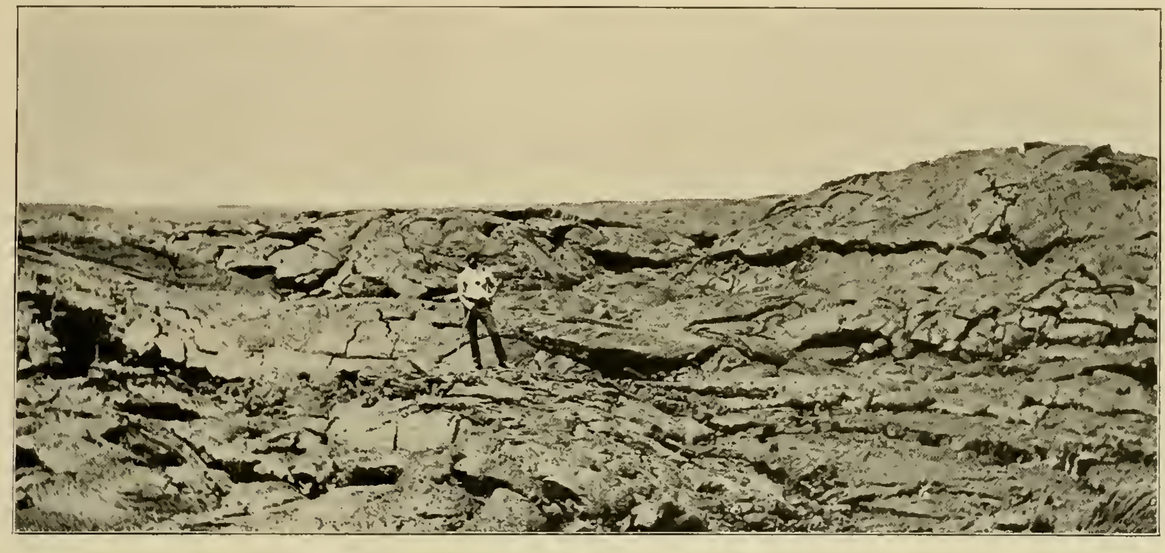


FIG. 105. THE FLOOR OF KILAUEA, 1890.

To return to Kilauea.

September 11, 1890. E. O. White.—We found two blowholes about six hundred feet apart, and a flow from each of them had covered several hundred square feet. The one furtherest to the south looks as if it would soon form a lake about the size of Dana Lake. We next went to Dana Lake and found it quite dead except for a little steam and smoke; walked well on to the lake but found it very hot toward the middle and could see fire in many cracks.

October 11, 1890. S. S. Peck and others.—Dana Lake was boiling violently and throwing up spouts and bombs of fire [see Pl. LX].

December 18, 1890. A. Gartenberg. (As seen from the Volcano House) 10 P.M.: a long ridge of fire is flowing from Dana Lake [?]. The new lake is spouting magnificently. 11 P.M.: There are now two fountains spouting alternately in front of Halemaumau. The new lake is in a great state of ebullition, several fountains can be seen playing high above the horizon.

January 2, 1891. L. A. Thurston.—Dana Lake and the new lake are in a continuous boiling condition throwing up lava from forty to sixty feet. Dana Lake has built up a wall around itself of from six to ten feet high, and the surface of the liquid lava is about ten feet above the surrounding country. I paced Dana Lake off along the base of the wall, making it eighty paces long. It is about one-half as wide. There are nine active blowholes within a radius of twelve hundred feet, this side of Dana about a quarter of a mile. [The debris cone of Halemaumau is a circular crater with a level fresh lava floor about a hundred yards across.]

February 23-25, 1891. G. Creswell Delamain and W. T. Brigham.—Brunner, by levels from Hilo, found the elevation of the Hotel verandah 3971.64.

March 6, 1891. J. H. Maby of the Volcano House.—At 9:30 P.M. one slight earthquake. At the time of shaking the cones of Halemaumau settled down. From February 10th to March 6th all the fires in the crater were very active and flows of lava were plainly seen over the floor of the crater from the house. At 9:10 P.M. on the 7th a slight shake was felt at the house. On the morning of the 8th on looking over the crater we saw that the cones of Halemaumau, the Dana Lake and Maby Lake had sunk out of sight. The cones of Halemaumau loomed up above the bed of the crater some two hundred or more feet before the earthquake of March 6th. Five years to a day since the last drop out in 1886.

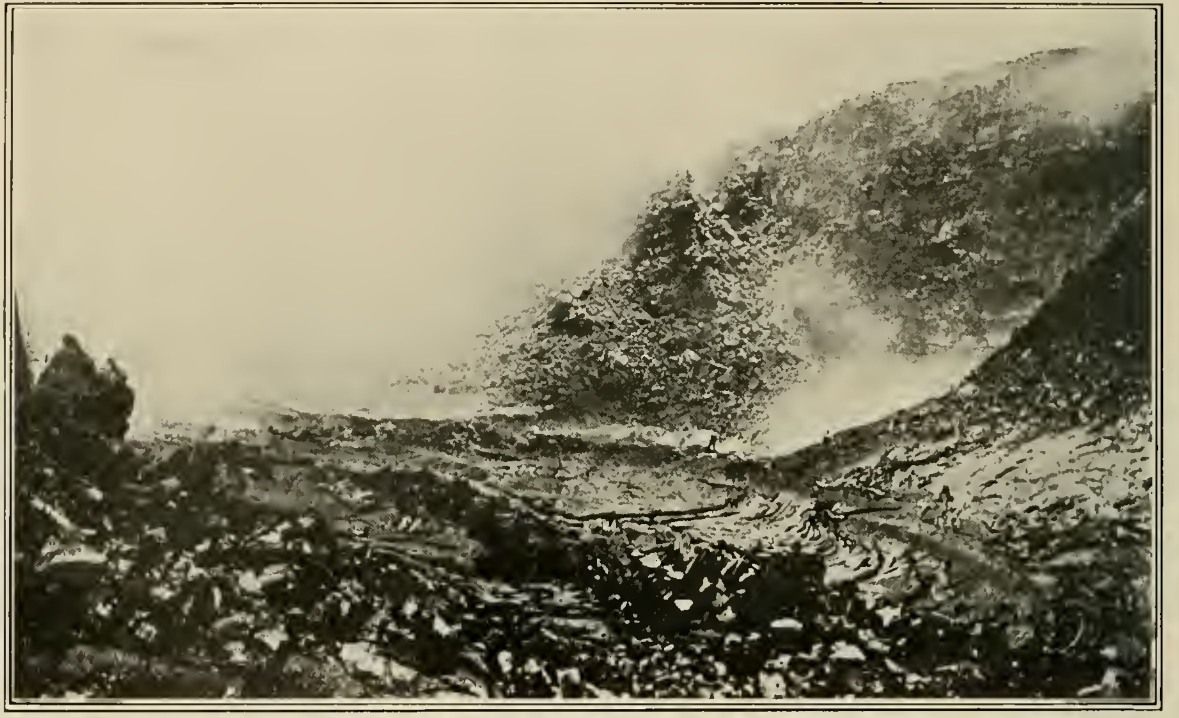


FIG. 106. REGION ABOUT HALEMAUMAU IN 1890.

March 15, 1891. W. W. Brunner.—Survey of Volcano road [from Hilo] finished. No fire in the crater.

March 18, 1891. Rev. E. P. Baker.—Went round the Halemaumau chasm: the brink is a sheer precipice, but the descent becomes tunnel-shaped a third or half the way down. It is smoking at the bottom.

April 3, 1891. Having seen the cone in the midst of the Halemaumau region a short time before its disappearance, I went to Kilauea hoping the empty pit might give some clue to the how or where of the vanished mass. It was no light bit of crust, that could be melted by the molten lava in a few moments, but a hill of crust, spatters and hardened lava of various form towering at least two hundred feet above the brink of the lake of molten lava which it nearly filled with its mass two thousand feet in diameter at the visible base. This had either stood or been constantly or intermittently rising with its base certainly in contact with the molten lava apparently in its hottest condition, and it had not melted, but, as it seems, had grown in size. I have been on similar cones, as well as this and found the material much like the crust of the crater floor, but here and there perforated with tunnels of irregular form and various size. From the orifices thus formed came at all times hot vapor and often molten lava, even at an elevation of half the height of the cone. It was unpleasant exploration, for the stifling sulphurous vapors had to be avoided as much as possible by keeping on the windward side, and the things I wanted to examine were often on the lee side. The foothold was of course insecure, but custom makes that tolerably easy to manage, and the heat was generally not unbearable. My examination convinced me that the substance of the cones was the crust of the lake from which the cone rose. It was the most refractory portion of the lava, and just here I must call attention to the need of a laboratory right on the spot to determine the relative fusibility of the lavas found in Kilauea; we know little enough of this problem, and more knowledge in this line would not only explain beyond cavil the aa formation, but why these layers of cooled crust should rise to such heights and not be melted again at the base.

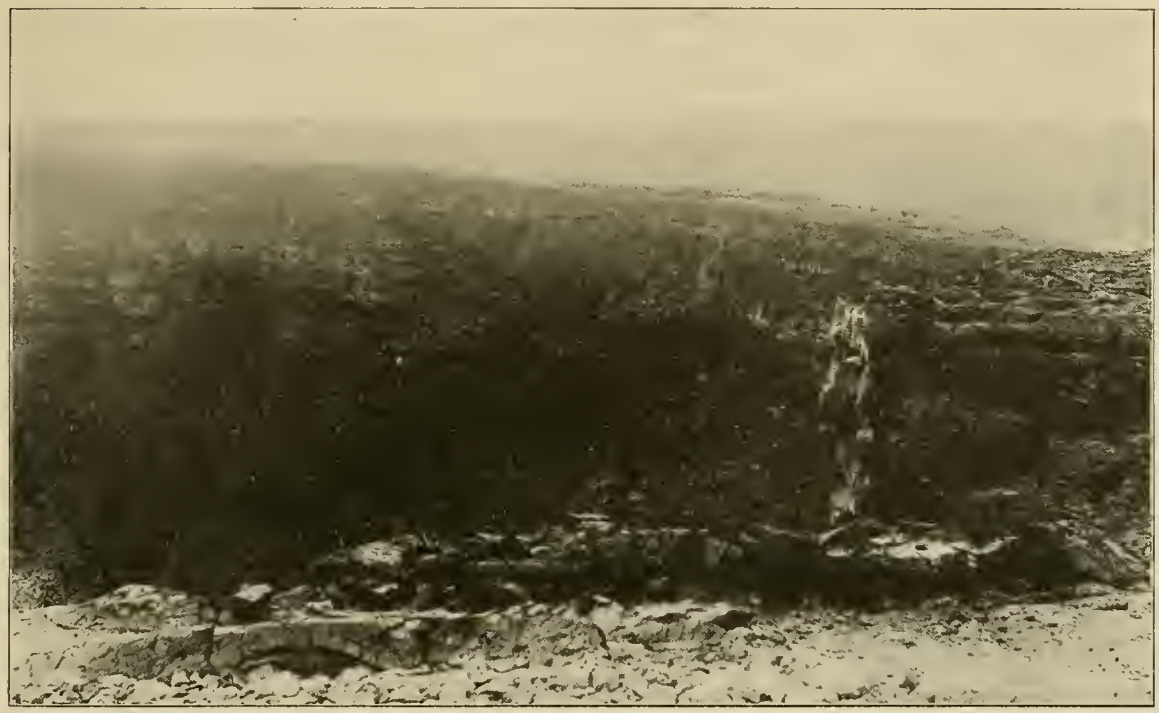


FIG. 107. HALEMAUMAU AFTER THE DOWNFALL. NOTE THE WONDERFUL NATURAL ARCH IN FOREGROUND.

The floating islands often seen on the Kilauea pools (see Pl. LXII) are, in my belief, the incipient central cones; their structure is identical, and so far as can be learned, without following the process through long months on the spot, the formative process is identical also. Is it necessary to imagine some mysterious "accensive force" pushing the crust up from below? Until we know the relative specific gravity of the cooled and hardened cellular crust and that of the compact molten mass of the lake beneath we cannot answer. It is hard, often very hard, for a scientific student to admit that he does not *know*, for his conscience tells him that he has not yet exhausted all the means at his disposal to complete the analysis, but surely, if anywhere, here in this mighty laboratory where God seems to be showing us His most wonderful ways, man must confess without shame to his own ignorance and failure to comprehend. He can well give up the attempt to conceal his ignorance in obscure phrases and pompous names. Giving a thing or a force a name does not explain what it is. This does not mean that we are to quit trying to learn, in our despair at our present failure. I have believed, and the belief is greatly strengthened at each succeeding visit to this volcano, that here is the place for a scientific exploration of world-making ways, far more important than the belated explorations of the life of the Pacific Islanders, either animal or vegetable, that nine scientific expeditions are now conducting from a European base.

I had seen the little mountain of lava that might have extended its edges until the lake was sealed, a condition that might have been followed by another explosive eruption like that of 1789. That would have been a simple result that could have been easily understood, for the remains of the mountain would have been scattered with noise and commotion about the neighborhood. Nothing of the kind was here; only a clean hole half a mile across and five hundred feet deep left on the site of a hill two hundred feet high surrounded by a lake of molten lava. The hill had gone almost without notice, only a slight jar—called by Mr. Maby, who, from his residence on the brink of Kilauea, was familiar with such things, a slight earthquake.

The pit was as Mr. Baker describes it in shape, but there was no smoke; clear hot air was rising from the bottom, but no part was obscured, only the shimmer showed the presence of air above the normal temperature. In one small place not far below the top, a little steam, not more than from one of the cracks near the Volcano House, was visible. I looked for caves, tunnels, some sort or other of subterranean machinery, but there was nothing but a clean hole closed at the bottom and without any suggestion that it led anywhere. As I sat on the brink I noticed what must have escaped Mr. Baker, the still red-hot lava in patches doubtless the overflows left when the rest of the lava descended. The color of the interior seemed strange, for there was not a sign of black lava of which the cone had been composed, but all was a light reddish gray. The funnel-like portion was composed of angular fragments of the same color, lying apparently at the steepest angle they could hold. There was great uniformity of size in these fragments, and the pile was absolutely clean from dust or gravel. When a portion of the wall of this empty pit falls in, a black cloud of dust rises like smoke for some time, as the fragments are ground by mutual attrition. I have noticed this, when at table in the hotel dining room the southerly wind has brought the black sand into the windows and made our food gritty so as to compel the closing of the windows for some time. Nothing of this kind was here. The cone disappeared during a night, and its mass was vastly greater than any fall of portions of the walls ever has been known. I looked about the crater for signs of this dust but found none. Can we believe the cone melted and ran out of the comparatively small hole at the bottom when it had for many months resisted the melting moods of the lake around it? The only indication that the lava was hotter than usual was this: as I left the Volcano just before the downfall, I was mounting my horse at eight o'clock in the morning and noticed a spatter cone on the edge of the lake so brilliant that it looked like an arc

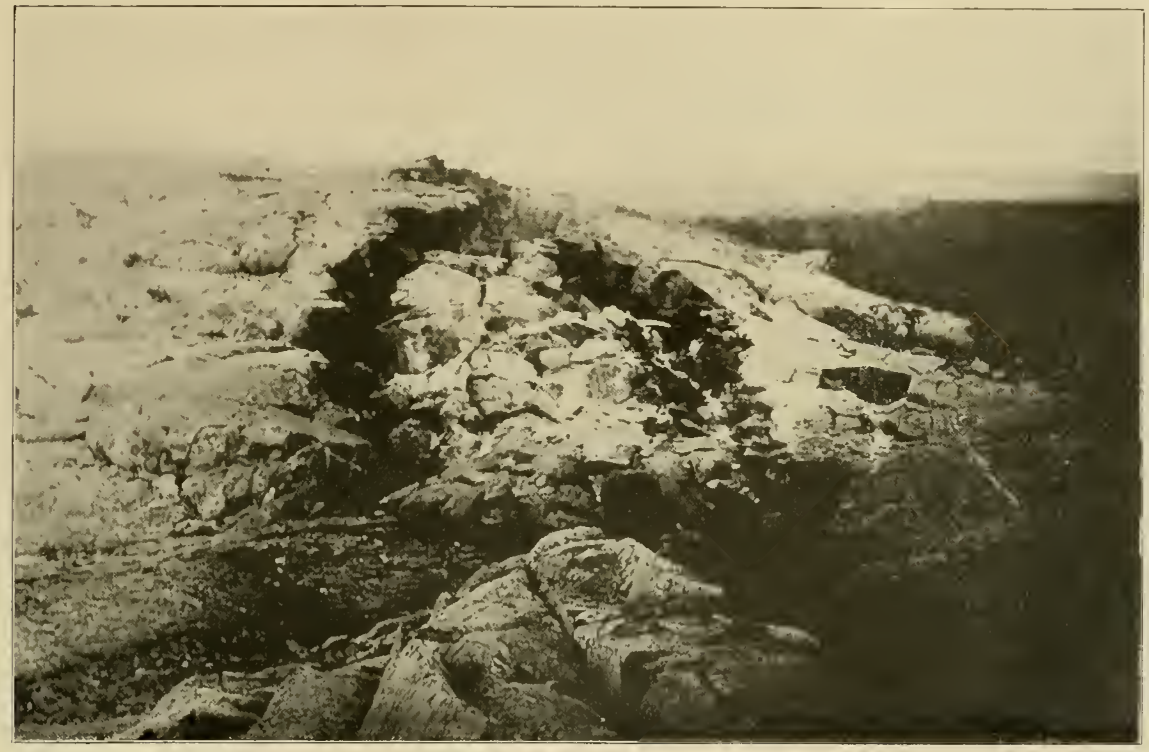


FIG. 108. CRACKS ON THE NORTHWEST BRINK OF HALEMAUMAU, 1891.

electric lamp in the full sunlight, a phenomenon I had never observed before; the brightest lavas look dull red by daylight.

It is hard to believe that the great cone dropped like a plummet into the lava sea below; it is almost as hard to think of its being ground up in this mill, and the only other way out of the difficulty, or the pit, is to melt the whole down as in a vast electric furnace. The tempter Radium stands by with suggestions for many a theory, but when our greatest chemists and physicists know so little of the part this powerful substance plays in terrestrial dynamics, we may well resist the temptation, although we know that radium abounds more in the Earth's crust than was at first supposed, and it has already been found in many lavas, and in the mineral springs of volcanic regions.

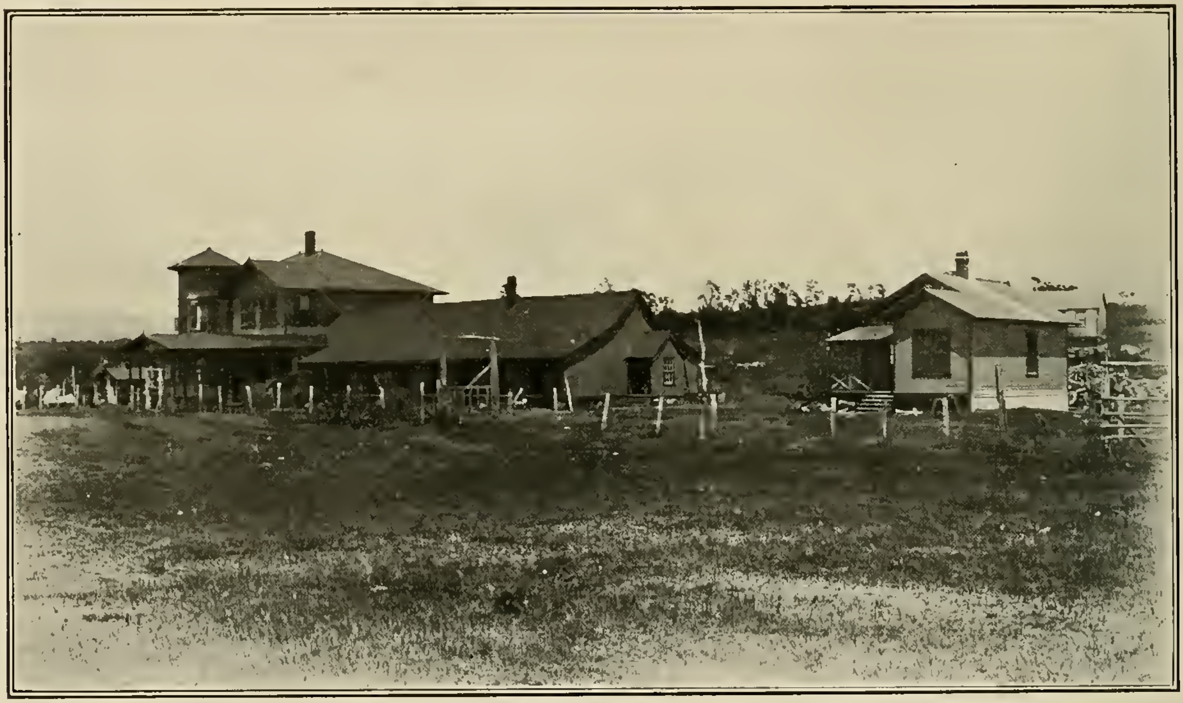


FIG. 109. NEW PORTION OF VOLCANO HOUSE.

Another thought came to me as I looked upon that great pit. There are at times many lakes of molten lava scattered over the bed of the main crater at Kilauea, but although while active, they spout lava fountains and show the ebullition of Halemaumau, when they go out of commission they leave no pit like this. Not one of them has done so. There is only a shallow depression with a floor as solid as any other part of Kilauea's bottom. We walk over these and, unless their history is known to us, might class them with the other subsidence phenomena which have at times involved more than half of the crater area. In all these cases, Dana Lake, the New Lakes, etc., Halemaumau seems to be not only the source but also the sinkhole.

The lava in these side pockets, shallow as they are, seldom exceeding fifty feet in depth, contains within itself all the forces needed to throw up fountains, open cracks, remelt crust, etc., that the main Halemaumau possesses. These surface pools act as relieving reservoirs, and suggest that there must be others beneath the crust to account for the sudden changes in level in the main lake observed by so many visitors. A fall of four feet in a pool a thousand feet in diameter means the transfer of a very large amount of matter and the exertion of a corresponding force. I have seen such a fall take place within three minutes time, and there was no sensible change in sound or motion, so far as the banks were concerned; the return in the case noted was slower, but it has been observed by others to come back as quickly as it went, indicating that the relieving reservoirs were not far away. From this excursus we must now return to the record.

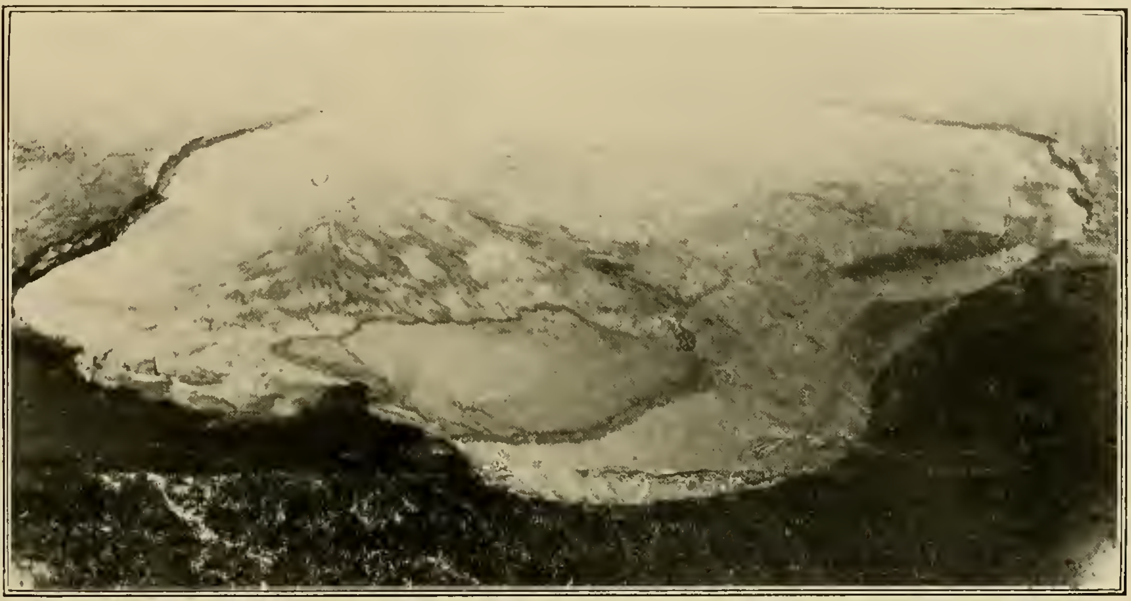


FIG. 110. HALEMAUMAU IN OCTOBER, 1891.

April 10, 1891. H. M. Whitney.—About 11 P.M. this day the fire returned in the sunken pit of Halemaumau after having been extinguished thirty-five days. When first inspected on the 11th April the fire was very small, occupying or puffing out of a small hole at the bottom not more than four or five feet in diameter.

May 19, 1891. W. R. Castle.—The pit is now 2000–2500 feet long and nearly as wide, greater axis N.E.-S.W. The inverted apex has now filled up with fresh lava to a depth in the centre of about 75 to 100 feet. [Reports intermittent explosions at intervals of five or ten minutes.]

June 29, 1891. Work completed on the new house. [See Fig. 109 on opposite page.]

August 8, 1891. Telephone line from Hilo completed.

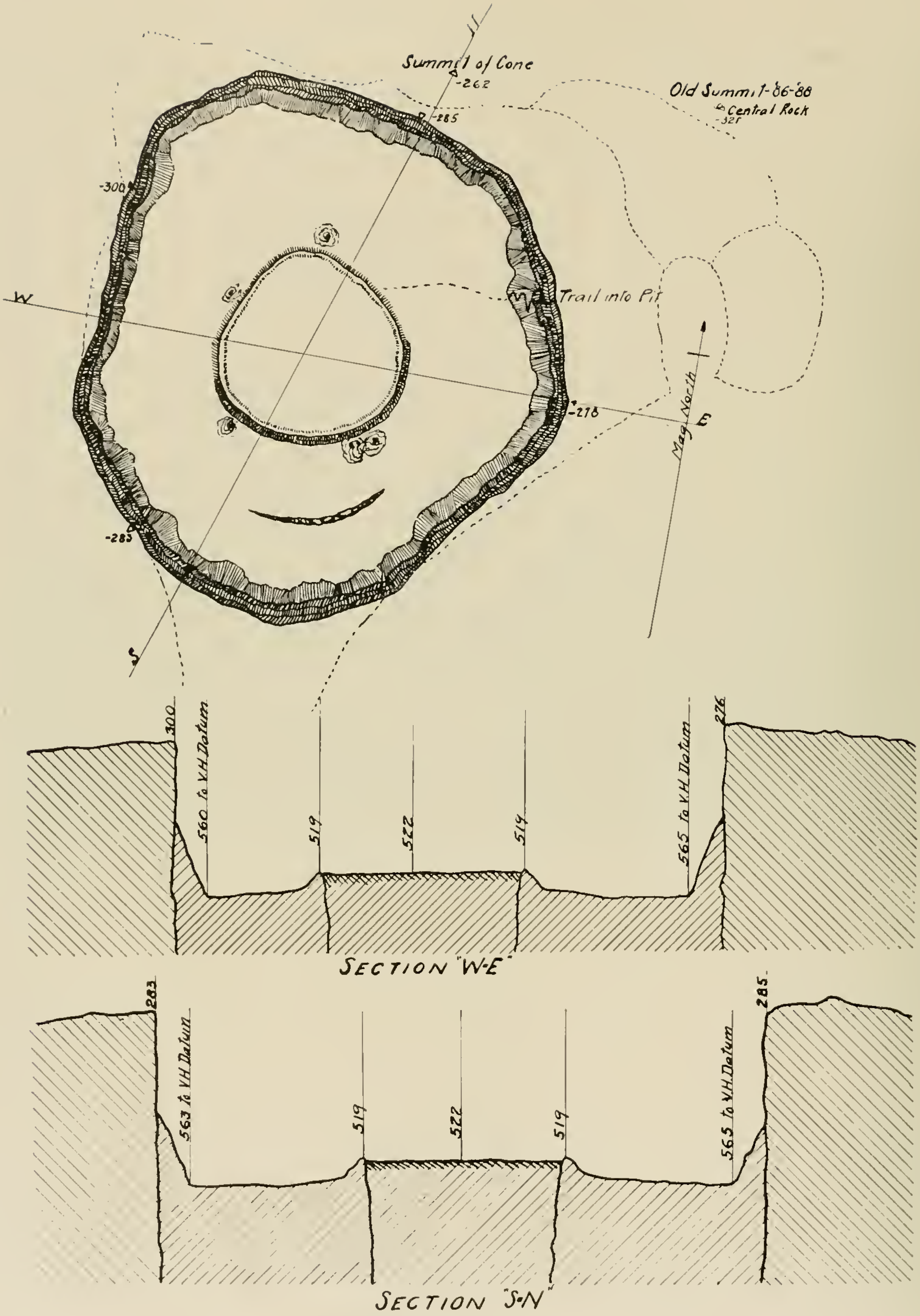

N
Summit of Cone
-262
-285
Old Summit-86-88
Central Rock
-325
-300
W
Trail into Pit
-278
E
Mag North
-283
S
300
560 to V.H. Datum
519
522
519
565 to V.H. Datum
276
SECTION "W-E"
283
563 to V.H. Datum
519
522
519
565 to V.H. Datum
285
SECTION "S-N"

FIG. III. DODGE'S SURVEY OF HALEMAUMAU, AUGUST, 1892.

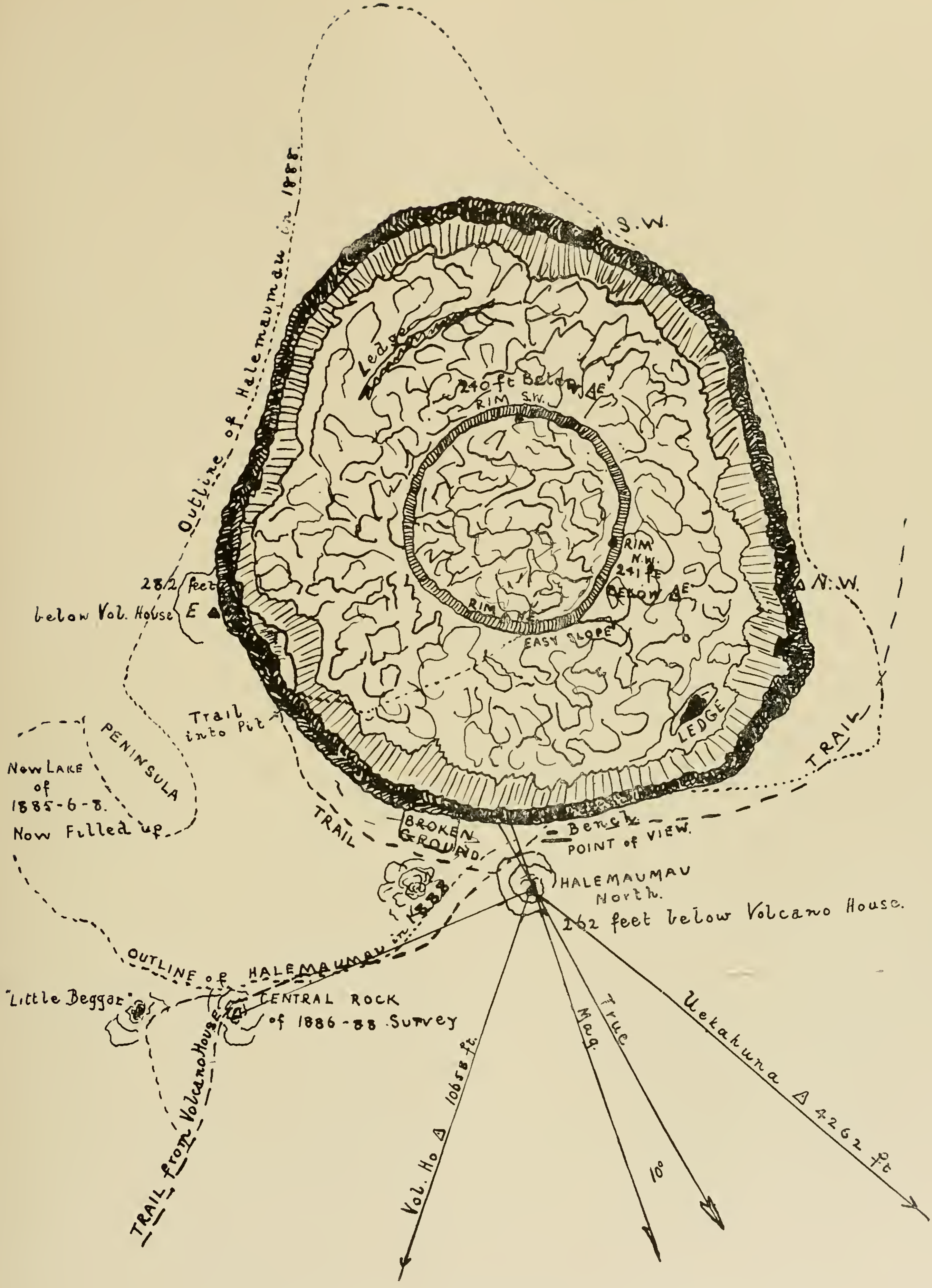

S.W.
Outline of Halemaumau in 1888
Ledge
240 ft Below AE
RIM S.W.
RIM N.W.
241 ft Below AE
RIM
EASY SLOPE
N.W.
282 feet below Vol. House E
Trail into Pit
PENINSULA
Now Lake of 1885-6-8.
Now Filled up
LEDGE
TRAIL
TRAIL
BROKEN GROUND
Bench
POINT of VIEW.
HALEMAUMAU North.
262 feet below Volcano House.
OUTLINE of HALEMAUMAU in 1888
"Little Beggar"
CENTRAL ROCK of 1886-88 Survey
TRAIL from Volcano House
Vol. Ho Δ 10658 ft.
Mag.
True
10°
Uekahuna Δ 4262 ft

FIG. 112. DODGE'S SURVEY AS COPIED IN THE VOLCANO HOUSE REGISTER.

September 14, 1891. Rev. E. P. Baker.—The molten lava has greatly risen within four months. In May last the liquid fire was 400 or 500 feet below the surface; it is now about 200 feet below.

September 23, 1891. E. L. Baldwin.—Lava about two hundred and fifty feet below floor of crater; lake very active.

October 3, 1891. W. T. Brigham (seventeenth visit).—The lava surface presented the usual appearance when not very active. A few cones lazily discharging small amounts of lava, but not easy to watch so far below the projecting edge of the pit.

November 30, 1891. H. M. Whitney.—The crater floor has been upheaved, and present lake of Halemaumau formed......at least 1000 to 1200 feet across, in full action, throwing up immense jets of lava. [I do not fully understand what Mr. Whitney means by the upheaval of the crater floor. On the same day Dr. Adolph Marcuse, of Berlin, was at the crater and records the following elevations as observed by aneroid: Volcano House, 0; lava floor, 480 feet; Half-way House, 420 feet; Little Beggar, 310; edge of Halemaumau, 260 feet.]

December 10, 1891. The surface of the molten lava sank about a hundred and fifty feet, remaining at that level for a month and then gradually rising.

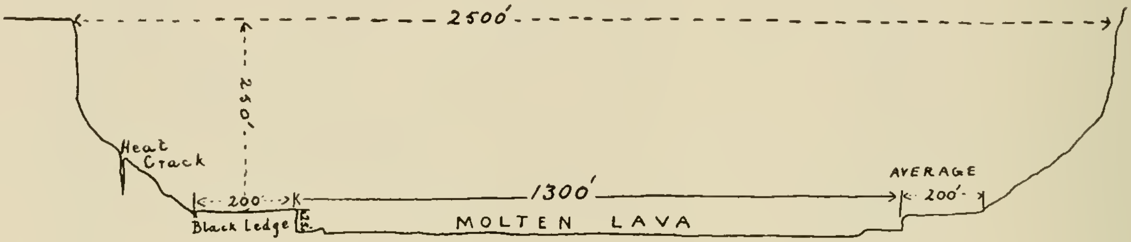


FIG. 113. SECTION OF HALEMAUMAU, 1892.

February 12, 1892. L. A. Thurston.—The lava is now within twenty-five feet of its former level. The entire surface is in a boiling condition, with bursts of spray averaging twenty-five feet, occasionally being thrown to a height of fifty feet. About half-way up the debris slope on the east side where the descent is made, heat comes up a crack.

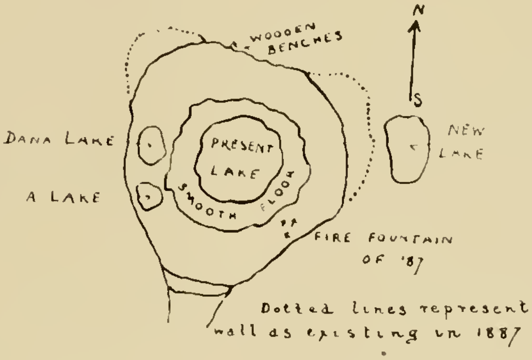
April 11, 1892. Rev. S. E. Bishop.—In 1887 [July] an area somewhat larger than that of the smooth black floor in the sketch on the opposite page [Fig. 114], was occupied by an irregular mound of debris which had been pushed up by the hydrostatic lifting of the lava column below.[122] Around the base of this mound was a narrow surface of comparatively smooth lava about a hundred and fifty feet below the upper floor around Halemaumau. On this floor, between the mound and the narrow pile of talus on the west side, lay "Dana Lake," so named by our party, small, but in quite active ebullition. [See Pl. LX.] Another lake lay immediately south, apparently smaller, but impossible to properly inspect on account of smoke. In the collapse of March 5, 1891, the whole of the above features disappeared, leaving a pit say five hundred feet deep. The lava soon reappeared, having left its cumbersome and unsightly mound somewhere down below. For one year it has been gradually rising in extremely regular form. The degree of activity in ebullition seems about as great as in Dana Lake in 1887 relatively to the surface occupied......On the main floor of Kilauea extensive overflows have occurred.

July 11, 1892. A. B. Lyons.—Almost daily overflows have taken place. The pit at top is about 2400 feet across; at base of cliff it is about 1900 feet. Lava lake 900 to 950 feet in diameter; black ledge 300 to 500 feet wide.

---

[122] Dr. Bishop accompanied Prof. Dana at the time he here refers to, and has perhaps in mind the "accensive force" of that distinguished geologist.

December 1, 1892. Peter Lee.—The crater of Moknaweoweo again active after a quiet rest of nearly six years, since February, 1887. The fire appeared last night between ten and eleven o'clock, quickly rising from the summit of Mauna Loa, without any earthquakes or previous signs of disturbance, and continued all night. This morning great columns of smoke are belching forth. [The fire only lasted three days.] The crater of Kilauea continues in its usual activity not seeming in the least affected by the eruption on Mauna Loa.


N
S
WOODEN BENCHES
DANA LAKE
A LAKE
PRESENT LAKE
SMOOTH FLOOR
NEW LAKE
FIRE FOUNTAIN OF '87
Dotted lines represent wall as existing in 1887

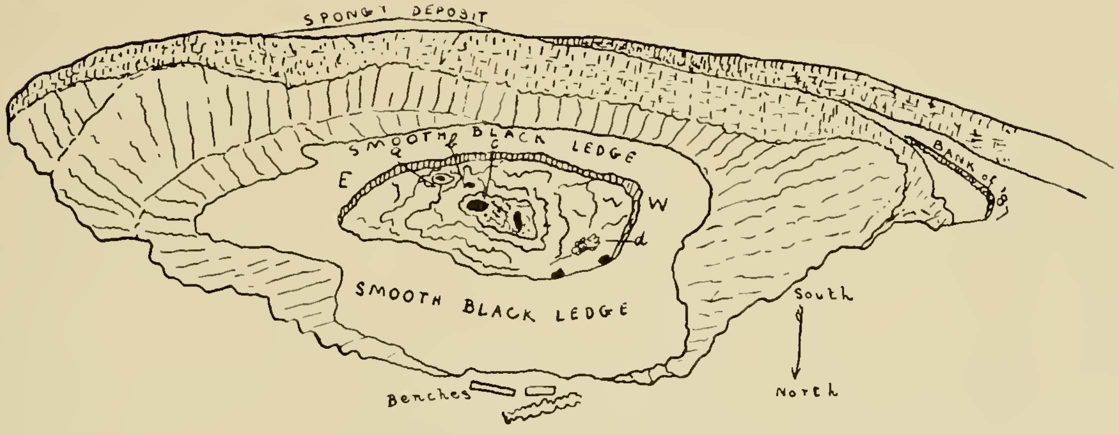

SPONGY DEPOSIT
SMOOTH BLACK LEDGE
a
b
c
E
W
d
BANK OF '87
SMOOTH BLACK LEDGE
South
North
Benches

FIG. 114. SKETCH PLAN OF THE LAKES. BISHOP.

July 19, 1893. W. R. Castle.—The lake named "Thurston Lake" has built up for itself a wall about thirty feet high; an even slope gives it the appearance of a cone......It filled and overflowed Sunday the 9th, falling about fifteen feet. Every outburst of fountain or surface swelling is accompanied by volumes of sulphurous vapor. As it rises from the surface it is red-hot, almost at once turning blue.[123] It is far more pungent than the vapor from sulphur banks near house.

March 26, 1894. W. R. Castle.—March 21, in the afternoon, between half-past one and two.....the entire surface of the lake appeared from the hotel to be in a condition of intense agitation, spouting and boiling with lava flowing over the side in several places. Suddenly on the north side stones, lava and "dust" were thrown high into the air with spouting columns of fire, and in the space of less than four minutes the north bank of the lake was tilted up to the height of one hundred feet or more, leaving an abrupt wall over the lake with a steep and broken slope towards the north. A stream of lava has constantly emerged from the northeast slope ever since.

---

[123] *Was not the red color borrowed from the crack or surface?*

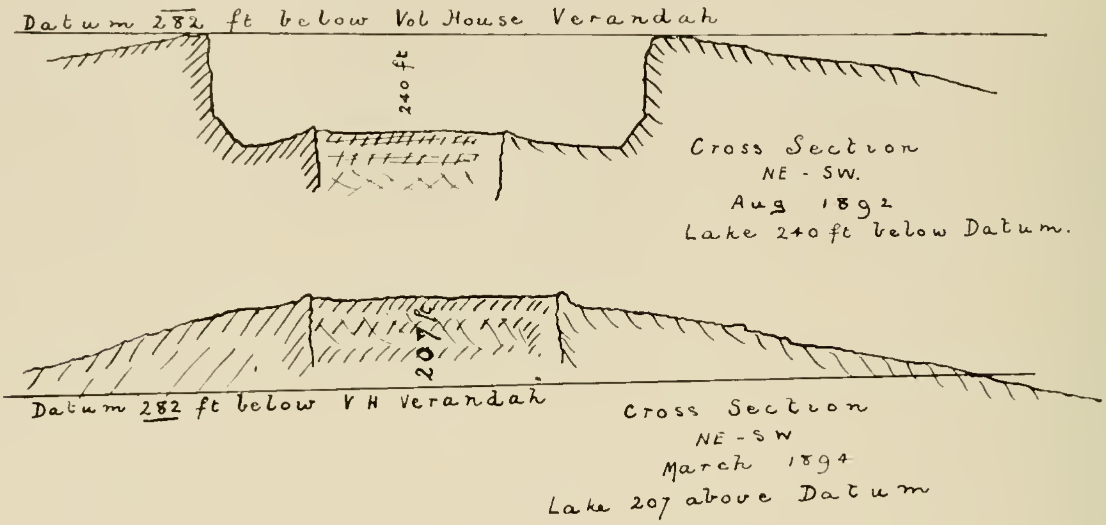


FIG. 115. COMPARATIVE SECTION.

1894

We now come to a most interesting change in the condition of Halemaumau. Fortunately Mr. F. S. Dodge of the Government Survey had surveyed this part of Kilauea in August, 1892 (see plan), and we have also his valuable surveys and measurements during and after the changes we are about to describe. In addition to these we have the observations of L. A. Thurston, Esq., whose frequent visits to the crater have made him familiar with its physical changes, and from these and other sources we can collect the story scattered in various newspapers, magazines and Volcano House Record. In 1893 the pit had been gradually filling up, mainly by the overflow of its molten contents, which, now here and now there, poured over the circular dam or rim which had in this case been formed more extensively and regularly than usual; but in addition to this elevation by filling, there was evidently a rising of the region around the pit, until in July, 1894, the rim of the lake was but seventy-five feet below the Volcano House level, and the whole surface was visible from the house. This condition is well shown in Mr. Hitchcock's view (Pl. LXVI). In August, 1892, the rim of the pit was 282 feet below the Volcano House datum, and the surface of the lake 240 feet below that. In March, 1894, according to Mr. Dodge's measurements, the lake was 1,200 feet long and 800 feet wide and its surface had risen some 200 feet in nineteen months. In July Mr. Thurston and party saw the remarkable changes that he reports as follows:

Upon arriving at the volcano on July 5, 1894, the principal change since Mr. Dodge's visit was found to be the sudden rising of the north bank of the lake, covering an area of about 800 feet long by 400 wide, which, on the 21st of March last was suddenly and without warning elevated to a height of eighty feet above the other banks and the surface of the lake, the lake being then full. The raised area was much shattered. Two blowholes shortly afterwards made their appearance on the outer line of fracture. April 18th, the hill thus formed began to sink, and on July 5th, was only about thirty feet above the other walls of the lake.

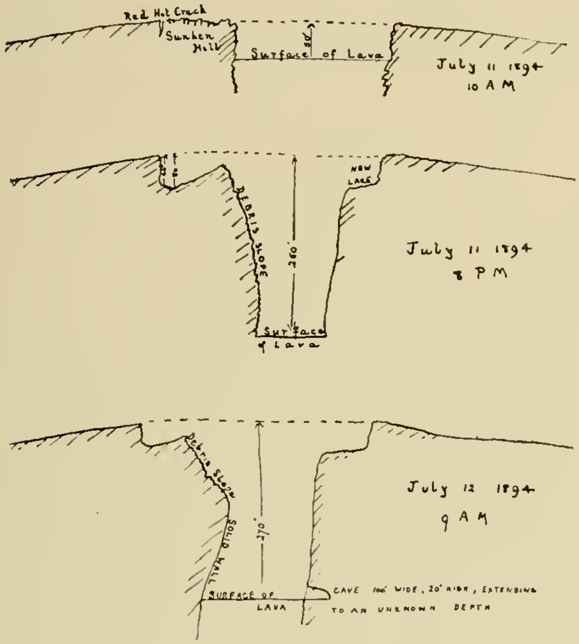


FIG. 116. SECTION OF HALEMAUMAU, JULY 11–12, 1894.

On the evening of July 6th, a party of tourists found the lake in a state of moderate activity, the surface of the lava being about twelve feet below the banks.

On Saturday, the 7th, the surface was raised so that the entire lake was visible from the Volcano House. That night it overflowed into the main crater, and a blow-hole was thrown up, some 200 yards outside and to the north of the lake, from which a flow issued. There were two other hot cones in the immediate vicinity which were thrown up about three weeks before. On Sunday, Monday and Tuesday following, the surface of the lake rose and fell several times, varying from full to the brim to fifteen feet below the edge of the banks.

On the morning of the 11th, the hill was found to have sunk down to the level of the other banks, and frequent columns of rising dust indicated that the banks were falling in. At 9:45 P.M., at which hour a party reached the lake, a red-hot crack from three to six feet wide was found surrounding the space recently occupied by the hill; the hill was nearly level; the lake had fallen some fifty feet, and the wall of the lake formed by the hill was falling in at intervals.

The lava in the lake continued to fall steadily, at the rate of about twenty feet an hour from ten o'clock in the morning until eight in the evening. At eleven A.M the area formerly occupied by the hill, began to sink bodily, leaving a clean line of fracture; the line of this area was continually leaning over and falling into the lake. From about noon until eight in the evening there was scarcely a moment when the crash of the falling banks was not going on. As the level of the lake sank the greater height of the banks caused a constantly increasing commotion in the lake as the banks struck the molten lava in their fall. A number of times a section of the bank from 200 to 500 feet long, 150 to 200 feet high, and twenty to thirty feet thick would split off from the adjoining rocks, and with a tremendous roar, amid a blinding cloud of steam, smoke and dust, fall with an appalling down-plunge into the boiling lake, causing great waves and breakers of fire to dash into the air, and a mighty "ground swell" to sweep across the lake dashing against the opposite cliffs like storm waves upon a lee shore. Most of the falling rocks were immediately swallowed up by the lake, but when one of the great downfalls referred to occurred, it would not immediately sink, but would float off across the lake, a great floating island of rock. At about three o'clock an island of this character was formed, estimated to be about 125 feet long, twenty-five feet wide, and rising ten to fifteen feet above the surface of the lake. Shortly after another great fall took place, the rock plunging out of sight beneath the fiery waves. Within a few moments, however, a portion of it, approximately thirty feet in diameter, rose up to an elevation of from five to ten feet above the surface of the lake, the molten lava streaming off its surface, quickly cooling and looking like a great rose-colored robe, changing to black. These two islands, in the course of an hour, floated out to the center and then to the opposite bank. At eight in the evening they had changed their appearance but slightly. By the next morning they had, however, disappeared.

About noon the falling lava disclosed the fact that the small extension [New Lake] at the right of the lake was only about eighty feet deep, and it was soon left high and dry; simply a great shelf in the bank, high above the surface of the lake. As the lava fell, most of the surrounding banks were seen to be slightly overhanging, and as the lateral support of the molten lava was withdrawn, great slices of the overhanging banks on all sides of the lake would suddenly split off and fall into the lake beneath. As these falls took place the exposed surface, sometimes a hundred feet across and upwards, would be left red-hot, the break having evidently taken place on the line of a heat-crack which had extended down into the lake.

About six o'clock the falling bank adjacent to the hill worked back into a territory which, below fifty feet from the surface, was all hot and in a semi-molten condition. From six to eight o'clock the entire face of this bluff some eight hundred feet in length and over two hundred feet in height, was a shifting mass of color, varying from the intense light of molten lava to all the varying shades of rose and red to black, as the different portions were successively exposed by a fall of rock and then cooled by exposure to the air. During this period the crash of the falling banks was incessant. Sometimes a great mass would fall forward like a wall; at others it would simply collapse and slide down making red-hot fiery landslides; and again enormous boulders, as big as a house, singly and in groups, would leap from their fastenings and, all aglow, chase each other down and leap far out into the lake. The awful grandeur and terrible magnificence of the scene at this stage are indescribable. As night came on, and yet hotter recesses were uncovered, the molten lava which remained in the many caverns leading off through the banks to other portions of the crater, began to run back and fall into the lake beneath, making fiery cascades down the sides of the bluff. There were five such lava streams at one time.

The light from the surface of the lake, the red-hot walls and the molten streams lighted up the entire area, bringing out every detail with the utmost distinctness, and lighted up a tall column of dust and smoke which arose straight up. During the entire period of the subsidence the lava fountains upon the surface of the lake continued in action, precisely as though nothing unusual was taking place.

Although the action upon the face of the subsiding area was so terrific, that upon the portion between the falling face and the outer line of fracture was so gradual that an active man could have stood on almost any portion of it without injury. Enormous cracks, twenty to thirty feet deep, and from five to ten feet wide, opened in all directions upon its surface, and the subsidence was more rapid in some spots than in others, but in almost all cases the progress of the action was gradual, although the shattered and chaötic appearance of the rocks made it look as though nothing but a tremendous convulsion could have brought it about. Another noticeable incident was the almost entire absence of sulphurous vapors, no difficulty in breathing being experienced directly to leeward of the lake.

At nine o'clock the next morning the lake was found to have sunk some twenty feet more; the banks at the right and left of the subsiding area, which had been the chief points of observation the day before, had disappeared into the lake for distances varying from twenty-five to one hundred feet back from the former edge, and the lower half of the debris slope had been swallowed up in the lake, disclosing the original smooth black wall of the lake beneath at a considerable overhanging angle. At the level of the lake, and half filled by it, was a great cavern extending in a southeasterly direction from the lake [see Fig. 116]. The dimensions were apparently seventy-five feet across and fifteen feet from the surface of the lake to the roof of the cave. It could be seen into from the opposite bank for about fifty feet. This may have been the duct through which the lava had been drained, although it manifestly was not at the bottom of the lake, for up to July 16th, that had continued to rise and fall from five to ten feet a day, and constantly threw up fountains, somewhat more actively than before its subsidence. The entire area of subsidence is estimated to be a little less than eight acres, about one-half of which fell into the lake. While the breakdown was taking place there were many slight tremors of the banks generally resulting in the precipitate retreat of the observers from the edge, but although the danger was great the spectacle was so grand and fascinating that the party returned again and again to watch it. At the Volcano House two slight earthquakes were felt on the afternoon of the 11th, and one vigorous one at 2 A.M. on the 12th. During the week several slight shocks were felt in the town of Hilo, thirty miles away, yet none were felt at Olaa, half way between, nor at Kapapala, fifteen miles in the opposite direction, although the latter is a place peculiarly susceptible to earthquakes.[124]

Mr. Dodge's survey made on July 30th (Fig. 118) shows the changes wrought in Halemaumau that Mr. Thurston has so graphically described. The figures both on the plan and sections are the distance below the Volcano House datum.

August 7, 1894. Walter F. Frear.—The lake was active, the largest fountain (Old Faithful) playing once or twice a minute, coming up each time as one, two or three bubbles, and then being quiet until the next burst; the other fountains, four to six generally at a time, playing often several minutes before quieting down. Old Faithful always played in the same place, this being the same place in which it played in March, '92, when I saw it on four different days. The guide says it has been in the same place ever since. The other fountains were not confined to any particular locality.

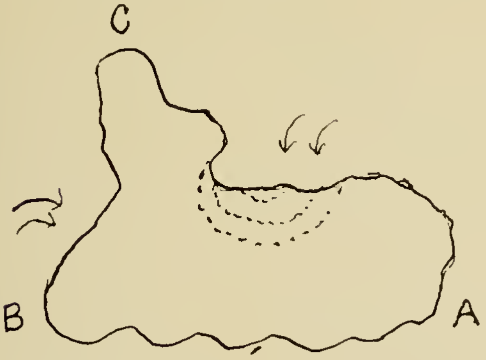


FIG. 117. OUTLINE OF ISLAND IN LAKE.

Aside from the surface appearance of the lake, there were at this time three points of special interest, (1) the change in height of the lake, (2) the falling in of the sides of the pit, and (3) the floating islands. The guide informed me that the height of the lake and the contour of the walls of the pit were substantially the same on July 24 as just after the drop of July 11. This was apparently so...... There was no change in the height of the lake and no falling in of the sides from the 24th until after the 27th. On the 28th and 29th there was much falling in of the sides, as shown by frequent clouds of dust, and on the 30th I noticed that the lake had fallen about fifteen feet. On August 2d there was also much falling in, and on August 4th I noticed that the lake had fallen about twenty feet more......

The guide said that two large islands made of pieces of fallen cliff had drifted at the time of the drop and become fastened, one to the north wall, the other to the south wall. These were still large on the 24th, but had mostly melted away by August 4th. There was one large island near the middle of the lake each time I went down. The first three times I could not see the whole of it from any one point from which I looked at it. On the 30th I got a good view from another point. Its shape was as in Fig. 117. Its length, A–B, was perhaps a hundred and thirty feet, its height at B about eight feet, at A about twelve or fifteen feet, and at C eighteen to twenty feet. Its surface was flat, except that there was a depression in the middle shown by the dotted lines in the figure. It was black and smooth as if covered by molten lava thrown over it. The sides were steep, but not all perpendicular. On August 4th its outline had changed slightly; it was nearly flat, the depression having been nearly filled; it was level, the lower portions having been raised to the height of the point c: the sides were for the most part perpendicular or overhanging and there were swift currents in the lake near the island in the direction of the arrows in the figure. On August 4th I saw another island to the south of the large one. It was oval in shape, perhaps twenty by thirty feet in its diameters, and about ten or twelve feet high, with perpendicular and overhanging sides. I visited the pit crater Makaopuhi July 31st, and on August 2nd I saw considerable steam issuing from cracks in it mostly at the intersection of the wall with the talus, that is, along the top of the talus.

---

[124] Thrum's Annual, 1895, p. 78.

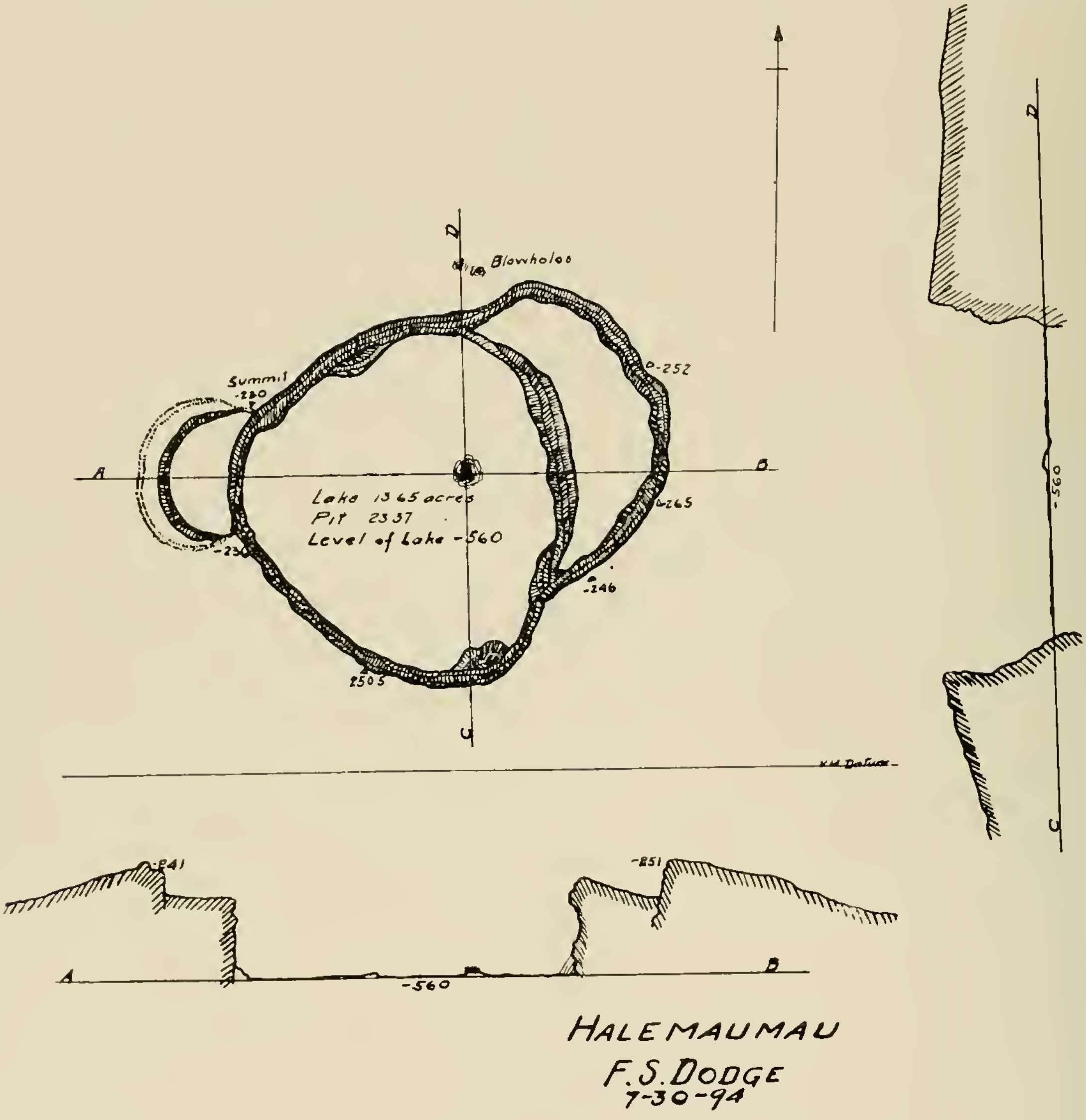
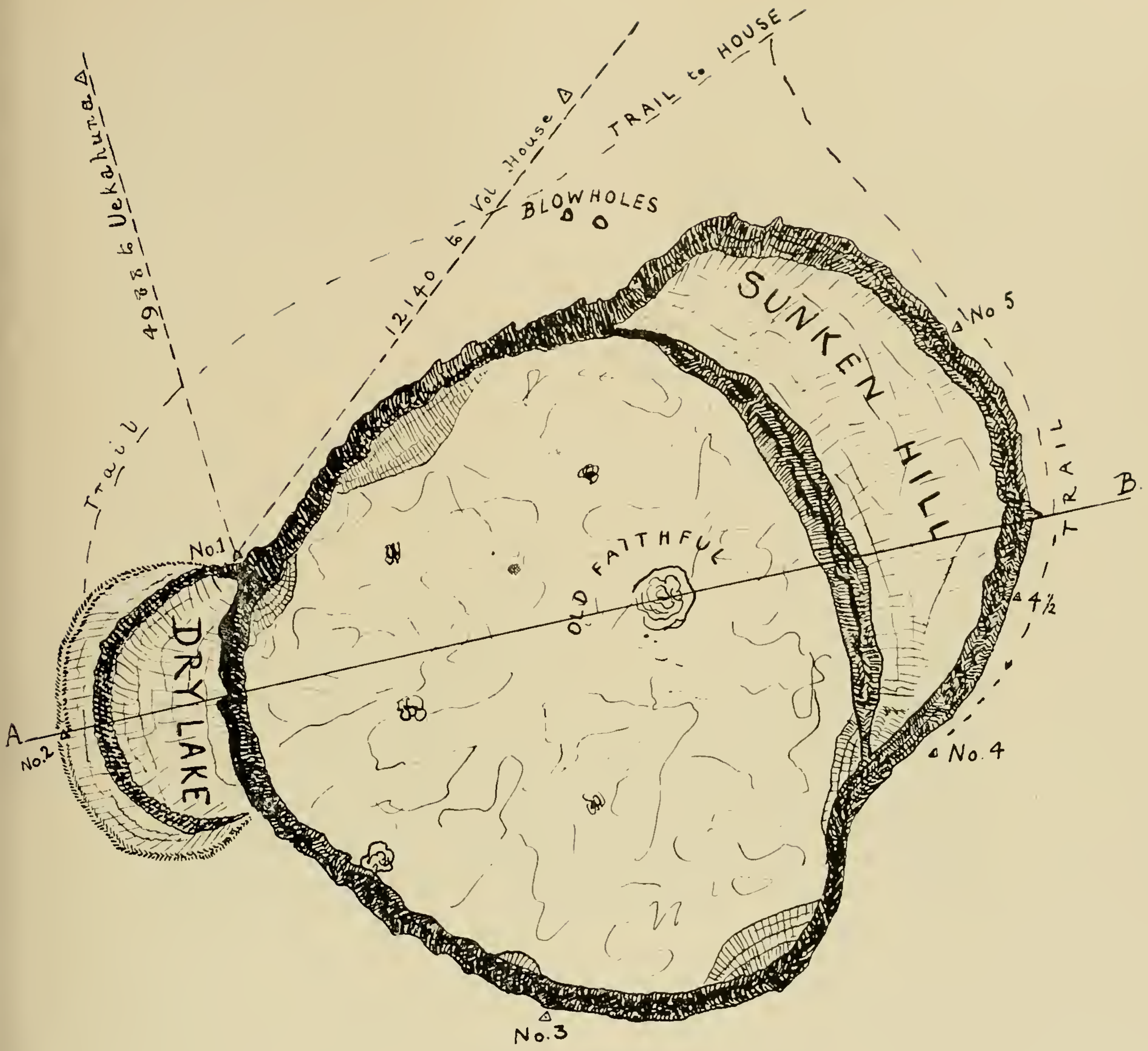

D
Blowholes
Summit
-230
-252
A
B
-265
Lake 13.65 acres
Pit 23.37
Level of Lake -560
-230
-246
250.5
C
V.H. Datum
D
-560
C
-241
-251
A
B
-560
HALEMAUMAU
F.S. DODGE
7-30-94

FIG. 118. SURVEY OF HALEMAUMAU BY F. S. DODGE, JULY 30, 1894.

May 28, 1894. Rev. S. E. Bishop found the lake much as in 1892.

September 13, 1894. Road from Hilo completed.


4978 to Uekahuna ∆
12140 to Vol House ∆
TRAIL to HOUSE
BLOWHOLES
Trail
SUNKEN HILL
TRAIL
B.
No 5
4½
No. 4
No. 3
OLD FAITHFUL
DRY LAKE
No. 1
No. 2
A

Section on Line AB.

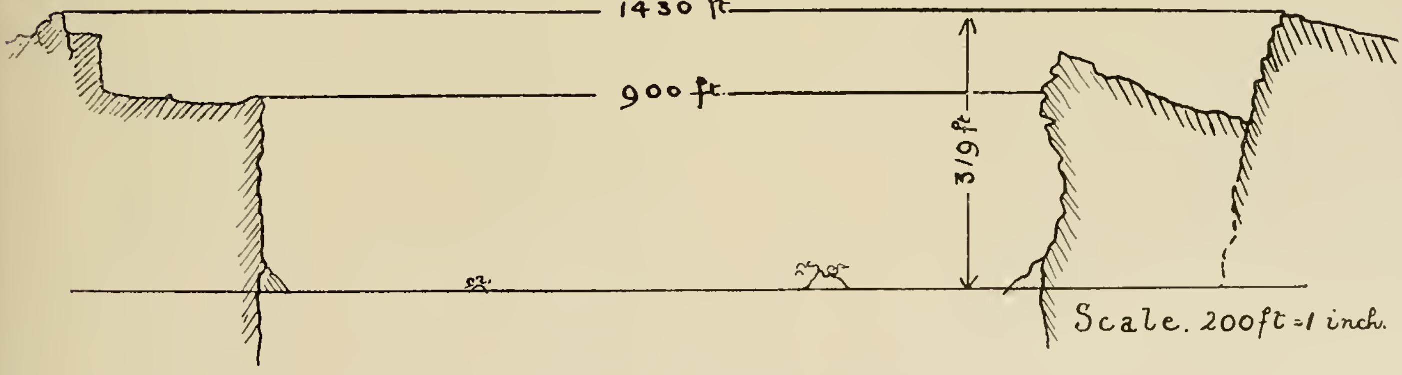

1430 ft.
900 ft.
319 ft.
Scale. 200ft = 1 inch.

FIG. 119. MR. DODGE'S SURVEY: ANOTHER COPY.

December 6, 1894. J. M. Lee.—The fire in the crater disappeared quietly during the past night.

November 6, 1895. Telephone line from Kailua to Volcano House completed this day.

January 3, 1896. The lava returned to the crater at 11:30 P.M. and formed during that night a lake about two hundred by two hundred and fifty feet. There has been no fire in the crater since December 6, 1894.

January 28, 1896. Fire disappeared again.

April 21, 1896. The crater of Mokuaweoweo broke out some time last night, but owing to dense clouds the smoke was not noticed until this morning at 7:25 A.M. With exception of a slight earthquake at 9:50 this evening everything is quiet, and at intervals when the clouds roll by we can see the fire brilliantly reflected in the sky. Kilauea is continually smoking, but otherwise inactive.

April 28, 1896. A party started for Mauna Loa's crater.

I was in Italy at the time of the eruption of Mauna Loa in 1896, in the very midst of the Vesuvian region, and so lost this interesting Hawaiian eruption; but we have most fortunately the record of two most competent men each in their department, Dr. Benedict Friedländer of Naples, a vulcanologist of experience here as well as in other regions, and Mr. D. Howard Hitchcock, whose paintings of Hawaiian volcanic action have not been surpassed. I am fortunately able to present the graphic account and photographs of one, and the painting of the other, although this last is but the ghost of the beautiful original in the Bishop Museum (Pl. LXVII). Dr. Friedländer's ascent was made, it will be seen, from the same side as my own in 1864. I quote his published account more fully than I otherwise should, as it gives so much more than the simple details of the volcanic action.[125]

On the morning of April 21st, 1896, while riding from Waiohinu, Kau, towards Honomalino in Kona, I noticed a large, white cumulus cloud, far above the fogs that frequently cover the slopes of Mauna Loa. The evening of the same day there was a bright fire-reflection visible from Honomalino; and because that glare was exactly in the direction of Mokuaweoweo, there could be no doubt that I had the good fortune to be in the right time in the right spot. Though the usual starting point for Mokuaweoweo be Kapapala ranch, or the Volcano House, and though I was not even sure if Mauna Loa was accessible from any other side—without great difficulty at least—I decided to try it, and had not to repent the attempt. The western slope of Mauna Loa is its shortest; and the condition of the roads or trails, on the upper part of the lava, turned out to be by no means worse than that on the southeastern slope. Succeeding parties probably would find it much easier, as we had to seek for our road from the upper limit of the woods on; none of our party had been up to the summit from this side, not even the guide, who only knew the trail through the forests and how to get up to a certain height...... Our party was composed of Mr. John Gasper, Mr. Charley Ka as guide, a native boy, my European assistant and myself.

We left Mr. Gasper's house on the upper Kona road on horseback in the early morning of April the 25th. The trail for some miles leads into a thick and most wonderful forest, in which I saw the largest koa trees and fern trees I met with on the islands. The trail itself was in places rather bad, but not worse than many others. In a height of about 4600 feet, a short distance before Mr. John Paris' dairy is reached, the forest becomes less thick and by degrees is succeeded by the form of vegetation characteristic of most of those districts of Hawaii where the formation of humus is not yet advanced sufficiently for supporting a richer vegetable life. Small shrub-like *metrosideros*

---

[125] Thrum's Hawaiian Annual, 1897, p. 72. Also in *Himmel und Erde.* Berlin.

(lehua), *cyathodes* (puakeawe), *vaccinium* (ohelo), are the most striking plants of that zone. We left our horses at a height of about 7500 feet, where they were able to get some wet grass, from which point we walked; but now after having explored the way, Mr. Gasper thinks he could take parties up to the summit entirely on horseback.

The kind of mist between fog and rain, so well known to many visitors to Kilauea, prevented us from going farther than about 8500 feet the first day. We pitched our tent; made up a large fire from dry lehua wood, and greatly enjoyed the contents of a number of tins of provisions. Towards sunset it cleared up, when a fine view of Hualalai and the green gentle slope below our place as far as the sea was afforded us.

Slowly the clouds dissolved also on the other side, except a large cumulus of the well-known shape of the Italian pine; a large mass of vapor floating to an enormous height and connected with the mountain, or with the crater, only by a narrow trunk of dim bluish smoke. The afternoon sun illuminated the cloud; its snowy white slowly turned yellowish, then, towards sunset crimson, and soon the volcanic glare became visible; first the narrow pillar, then the whole cloud formation becoming aglow from the incandescent matter beneath. A cool wind blew over the almost barren land and its scanty shrubs. We crept into our tent after having impressed our memory with that wonderful and highly characteristic sight of Mokuaweoweo's threatening volcano cloud in the clear moonlight.

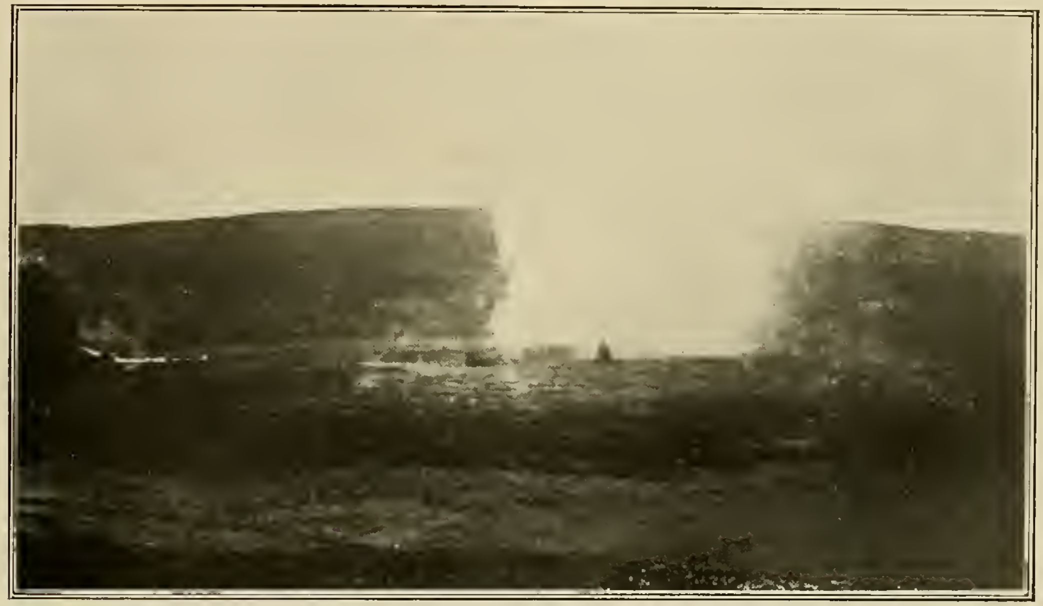


FIG. 120. ERUPTION OF MOKUAWEOWEO, 1896. DR. FRIEDLANDER.

The next morning we started early. Tent, photo outfit, water and provisions were carried on a pack mule, the only animal we took above the forest limit and to within a short distance of the summit......In consequence of the flatness of the top of Mauna Loa you never see the summit until you are right there. Invariably the upper horizon is limited by a lava rim that looks exactly as if it must be the edge of the crater: after you reach that rim, another hill becomes visible, and when you reach it there is another still. More than ten times one or another was convinced that it was the rim of Mokuaweoweo; but my aneroid contradicted them and was right. Unfortunately the native boy and my attendant were not far from being quite used up. We had to stop frequently and so progressed very slowly indeed; but we pushed on and in the afternoon were as high as 13,000 feet. After we reached this altitude we left the mule and the two exhausted men behind, because the upper part of that side of the summit was mostly formed of the aa kind of lava. While the two men pitched the tent, the rest of the party passed on without delay. We heard distinctly a surf-like noise that indicated the presence of lava fountains; the pillar of bluish smoke was quite near; and yet no trace of the immediate vicinity of the crater was discernable......

The upmost top of Mauna Loa is almost level, with only a very slight uphill slope to the rim. At once the opposite side of the crater becomes visible; a few steps more and we were on the brink of a perpendicular precipice and saw the whole crater. What was noticeable in that first moment was the rather considerable amount of snow forming narrow white lines on the opposite crater wall; and two large lava fountains, the bright reddish yellow color of which made a fine contrast to the blackish crater bottom......

The surface of the lake was crusted over, but rent by a very large number of crevices, through which the glow was slightly visible in the daylight and very bright in the night......During my presence there were two large and one small lava fountains, the former of which played with great regularity and without any interruption. We were looking against the longer diameter, which followed the line on which the fountains were playing; apparently they started from a rather straight crack. Their height was difficult to estimate from our place of observation, as the downward look was too steep: but I do not believe that the largest was more than 50 feet high. A succeeding party, three days later, reported far larger figures: 150 to 200 feet. Either one of these estimations is very far from the truth, or, the fountains had increased their height in the lapse of three days; the latter supposition seems to me more probable. The color of the fountains was very bright, more yellow than reddish, even in the daylight; after sunset they were almost dazzling, and also the system of cracks was very striking. I succeeded in obtaining lasting evidence which proves that the fountains were not very far from real white-heat. The full moon and the fountains affected the photograph plate almost alike. As the fountains of Moknaweoweo came out absolutely black in a five second exposure with an F. 6.3 lens on a 26× Seed's plate, I am convinced that a much shorter exposure would suffice......My picture (Fig. 121) was taken only half an hour after sunset, when the reflected

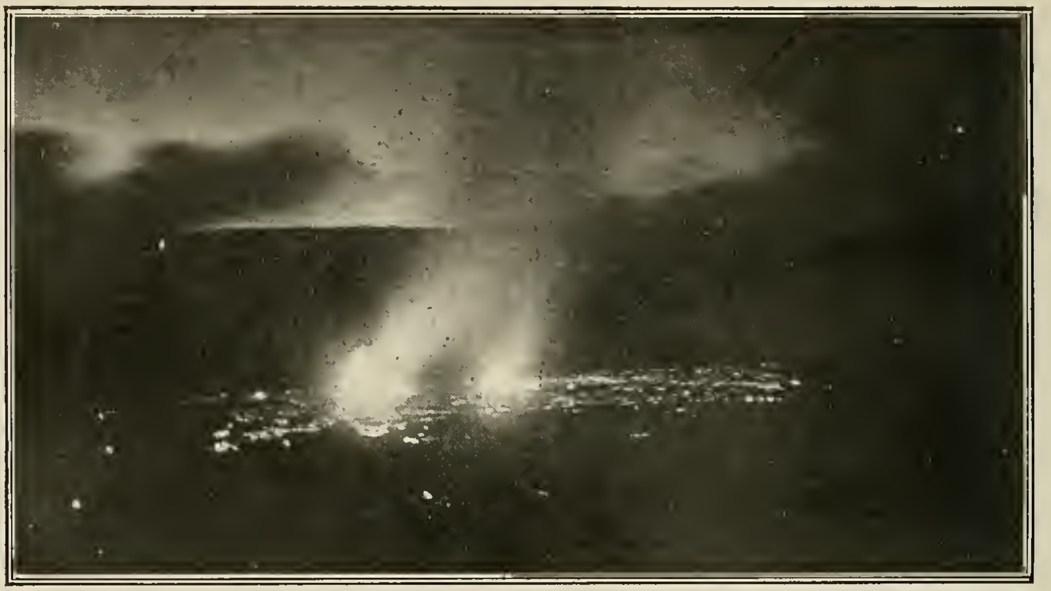


FIG. 121. ERUPTION OF MAUNA LOA, 1896, AT NIGHT. DR. FRIEDLANDER.

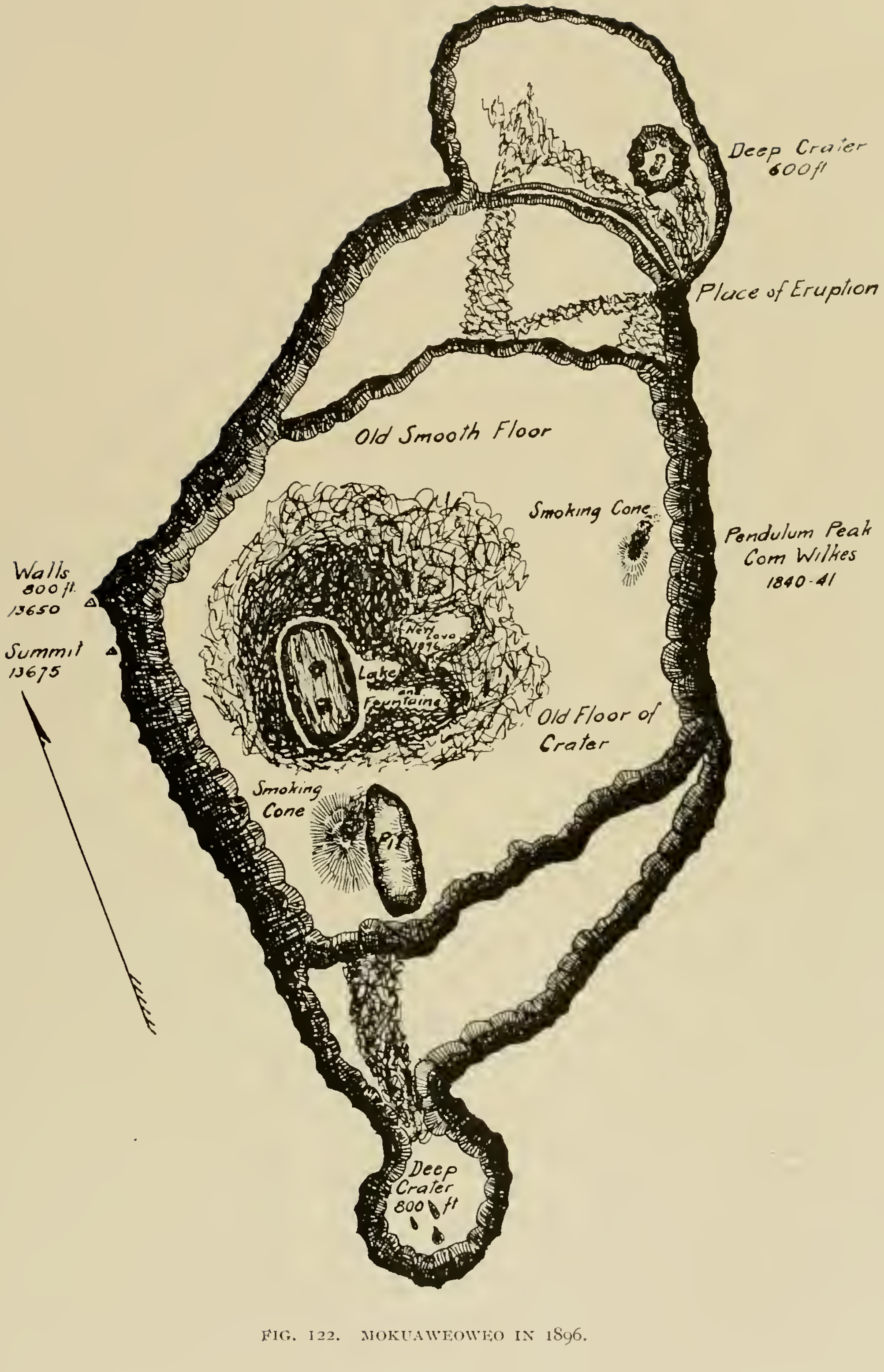

Deep Crater
600 ft
Place of Eruption
Old Smooth Floor
Smoking Cone
Pendulum Peak
Com Wilkes
1840-41
Walls
800 ft.
13650
Summit
13675
New Lava
1896
Lake
an
Fountains
Old Floor of
Crater
Smoking
Cone
Pit
Deep
Crater
800 ft

FIG. 122. MOKUAWEOWEO IN 1896.

daylight was still pretty strong. A gentleman of the other party exposed his plate in the very night and obtained not only the fountains but the cracks also......

In closing, the differences between the activity of the Kilauea lake and that of Mokuaweoweo are to be enumerated. From the molten lava of Kilauea there arises only a thin smoke, that in the reflected light is intensely bluish, and if looked at against the bright sky, yellowish brown. A volcano cloud proper does not exist at all as a rule, and only under certain circumstances, mostly in the early morning and again at sunset. The invisible overheated steam will condense to a cloud, but I invariably noticed that the seeming volcano cloud was a free floating mass of condensed steam without any appreciable connection with the lava lake. Mokuaweoweo, on the other hand, as long as it was active, nearly *always had* a cloud; and that cloud *always* had a noticeable trunk or pillar of smoke: the latter, as I could see from the top, arose almost entirely from the fountains. These, though they seemed to me far less high than to the party of April 29th, yet were higher than any I had seen in Kilauea; and furthermore, I almost believe (though I could not affirm it positively) they were somewhat brighter than those of Kilauea.

I may add that the cloud commonly over Kilauea does not have a visible connection with the lava below, but is far from a mere passing cloud (many of these sweep across the crater), but remains stationary a long time, and is at such a height that it is visible from a great distance, especially when illuminated by the molten lava beneath. In Hitchcock's picture the considerable heat of the distant fountains is indicated by the melted snow on the lee side of the crater: on the right, Mauna Kea, snow-capped, is seen above the rim.

May 6, 1896. The eruption on Mauna Loa ceased after fifteen days action.

July 11, 1896. Fire returned to Kilauea at a depth of six hundred feet. This activity continued for three weeks without increasing the lake. After this the lava lake gradually disappeared and the fire was confined to a cone in the bottom, from which lava occasionally poured out. This kept on during August and September, when the last sign of fire disappeared.

June 24, 1897. J. M. Lee.—There was again a little fire visible—lasted three days only—down in a cave. For some months smoke has been abundant and dense.

1899

Kilauea still remained inactive, but on the morning of July 4, 1899, Mauna Loa commenced a short eruption from a crack not far from the point of the eruption of 1880–81. In July, 1899, Professor C. H. Hitchcock saw the eruption from a distance. Prof. Albert S. Bickmore, of the American Museum, New York, was here with his photographer, Mr. C. C. Langill, who made some good views of the eruption. Of some of these I have colored lantern slides. Three years before the guide Gasper had told Dr. Friedländer that he thought he could take a mounted party to the summit from the west side, and this year he made good with several parties. We have a detailed account from one of those who visited this eruption with Gasper, Mr. A. B. Ingalls, of Oahu College,[126] from whose published account we gather the following facts: Reaching Mokuaweoweo on the western side, after much the same experiences that have been related by Dr. Friedländer, great volumes of steam were

---

[126] Thrum's Annual, 1900, p. 51.

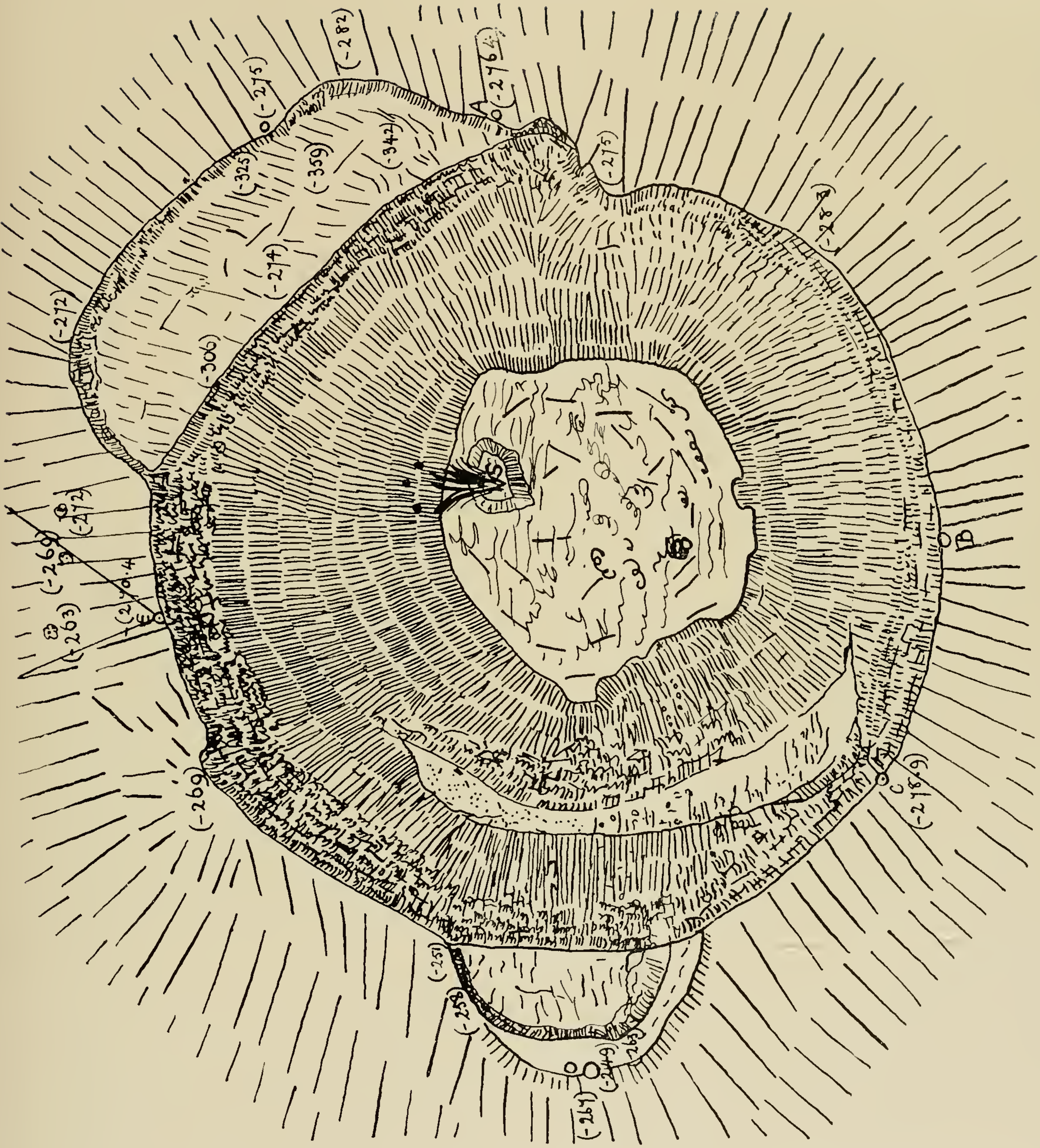

(-282)
(-275)
A
(-276.4)
(-325)
(-359)
(-342)
(-275)
(-28)
(-274)
(-272)
(-306)
(-272)
(-269)
(-263)
E
B
(-269)
C
(-278.9)
(-251)
(-258)
(-264)
(-264.9)
263

FIG. 123. HALEMAUMAU.

seen to the south of the main crater, probably from the already described cracks common in that region. There was a crack in the crater floor roughly parallel to the western wall, west of the major axis of the pit, from which steam jets in considerable number, but not of much activity, were the only signs of any eruption. The floor was much like that of Kilauea, and no traces of the lake of the previous eruption are mentioned. Making their camp where they reached Mokuaweoweo, Mr. Ingalls with a few companions passed around the northern end of the crater, and by a difficult trail descended the mountain slope some three or four thousand feet to the source of the outbreak. The cone from which much of the lava was flowing is shown in Fig. 124. As near as they could estimate, the fountain was one hundred and fifty feet high. On the return to camp they met an unexpected danger. To quote Mr. Ingalls:

> Having remained by the crater several hours, we began to retrace our steps to our camping place, ten or twelve miles distant on the summit of the mountain. We had proceeded but a short distance when we noticed that the wind had shifted around 180°, and that the fumes from the upper pile were drifting down and across our former trail, and also far off to the northwest were hovering down upon the slopes of the mountain. This caused me a little anxiety as soon as I saw it, but we tramped along until we encountered the fumes. Then anxiety became acute; the sulphurous fumes were dense and strong. We attempted to pass through, but could not do so, either close to the base of the cone or farther away to the northwest. The choking sensation in the lungs, and irritation in the nostrils could not be endured.
>
> The situation looked serious: to cross the hot aa between the lower and upper crater and thus gain the windward side of the upper crater was absolutely impossible. We tried it. To attempt retreat down the mountain towards Hilo was out of the question. The general direction to Hilo was down the slope over the barren lava to the forest, and then a two days trip through the jungle, unless we might accidentally strike a trail, and worse than all that, we had no water for such a trip; every canteen was dry......Just then the wind shifted 10° more, crowding us toward the hot aa. At this moment we began to utterly depair of ever reaching civilization......Then one of the party, studying the cloud of fumes, saw near the top of the cone a patch of blue sky through a rent in the smoke. This less dense portion was slowly drifting along with the rest. Brief calculation from its motion indicated about where it would settle down upon the rocks to the north. "Fellows, there's our chance! Come on!" Snatching up packs and canteens we ran with all speed to the spot, made a dash through the vapors, which choked us terribly and irritated both eyes and nostrils. The boy with the heavy camera plates falls down, overcome. Grabbing his pack I pushed him up and urged him on a few steps farther. They closed in behind us, but we were on the upper side of them now, and were safe. Never again, as we looked back on those vapors during the night, did we see another break in them. The remainder of that night and part of the next morning were occupied in making the ascent of the slopes and reaching again our summit camp. Without water, with sore feet and painful steps, with aching muscles, with hands benumbed with the cold, freezing air, up over the shoe-cutting aa we stumbled along, picking our way as best we could by the glare from the volcanic fires and the dim light of a quarter moon. Someone, exhausted, dropped down; we all rested a little; then up again until another dropped exhausted. After a time exhaustion became so great that to sit down to rest meant to immediately fall asleep; but the freezing wind piercing our garments chilled us to the bone, and presently we would awake with chattering teeth and quivering limbs. Thus the night passed. Morning began to dawn; the sun lighted up the distant clouds below us, and the smoke of the volcano, still drifting off to the north, hung like a claret-colored scarf against the feathery whiteness of the clouds beyond. A cheerful warmth in the sunbeams was very welcome.

Two streams flowed down the mountain, one toward Kau—this lasted only ten days—while the other and larger ran toward Hilo in the track of so many others, finally ceasing July 23d. Then came severe earthquakes, felt in various parts of the island during that day, but no harm was done; neither did the flow of three weeks do any harm as it passed through a region already blasted by previous streams of comparatively recent occurrence.

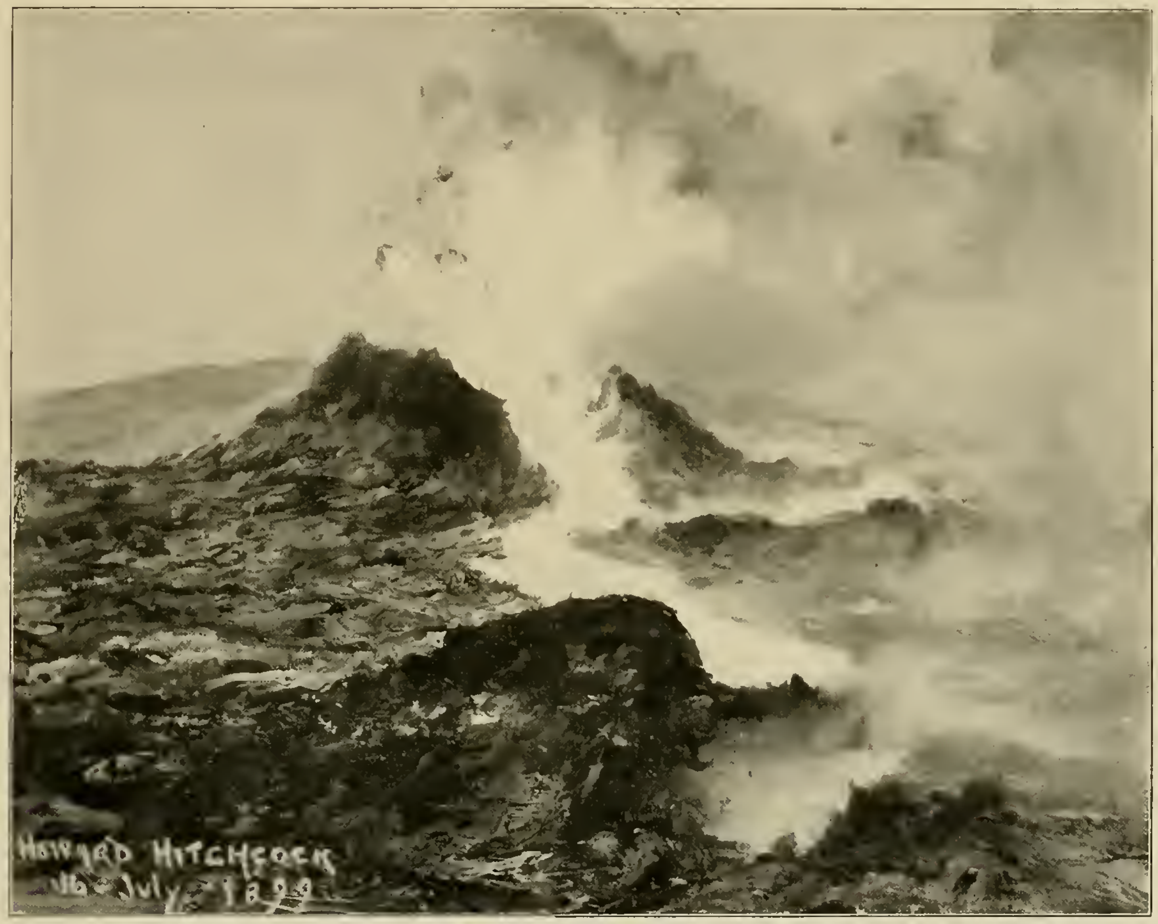


FIG. 124. A SOURCE OF ERUPTION, 1899. HITCHCOCK.

January 14, 1898. Frank Godfrey.—Not a sign of life [Kilauea].

March 26, 1898. L. A. Thurston estimates the pit as 800 feet deep and 150 feet in diameter at the bottom. He also notes increased heat in the crack parallel with and four hundred feet distant from the north wall. "It is sizzling hot a foot back from the edge and shows a cherry-red about twenty feet down. This is the first fire seen in the crater since June 24, 1897."

March 2, 1900. L. A. Thurston.—There was a breakdown filling the "bottomless pit," and some fire. [577]

February 14, 1901. L. A. Thurston.—Very little sulphur vapor arises from two or three spots on the north and east sides.

August 3, 1901. W. T. Brigham.—Found Halemaumau a conical pit clear to the bottom; some sulphur on western wall.

August 25, 1901. Fred Waldron.—At 10 P.M. a lake four hundred feet in diameter has just formed in the bottom of Halemaumau on the Kau side. It has the shape of an irregular quadrilateral.

September 12, 1901. L. A. Thurston.—The new lake has subsided, leaving a black ledge 100–150 feet above the present bottom .... No fire is visible in the daytime, but it can be seen at night.

June 12, 1902. L. A. Thurston.—No change in crater rim since February 14th. Pit generally filled with sulphur vapors.

August 25, 1902. F. Waldron.—At 10 P.M. a bright glow was observed over Halemaumau; on going over it was found that a lake had formed at the extreme bottom near the base of the wall on the Kau side. This lake is now about 400 feet in diameter.

September 12, 1902. L. A. Thurston.—The new lake at the bottom of the pit has subsided, leaving a black ledge at an estimated height of 100-150 feet above the present bottom of the pit.

October 13, 1902. W. E. Skinner.—Brilliant display over surface of lake.

October 20-27, 1902. Whitman Cross, of the United States Geological Survey.—On Monday the 20th instant, there were almost no signs of activity. The lava flow produced by earlier action was recognizable. With a tape line parallel tangents to the circular outline of the crater were drawn, which were 1500 feet apart, representing the diameter. The depth to the consolidated lava was estimated to be 825 feet; and the north-south diameter of the same was 575 feet. The vertical wall on the south was deeper than upon the opposite side, while in the first case there was a gradual slope to the lava floor. On the other side the slope was higher up and connected two walls. On the north edge of the lake there was a blow-hole or spatter cone about twelve feet high exhibiting two small glowing spots, and sulphurous fumes arose from the cone without noise. October 23d there was a sound of escaping gas from the blow-hole, like the sharp puffs of a locomotive getting under headway; they were irregular, though often strenuous. At 3 P.M. a part of the top of the cone was blown off, followed by the sound of thrashing and surging lava. At every throb splashes of lava were thrown out of the orifice and the cone grew rapidly. At 3:35 P.M. the whole northwest side of the mound was broken down and a torrent of lava burst out like water from a pipe. The flow was steady, with occasional spurts throwing small masses a few feet into the air.

The lava was liquid, red-hot, changing to dull red and black as the crust formed, and as it spread out the domes and ropy lines so characteristic of the general floor of Kilauea made their appearance. By 5 P.M the flow had covered half of the floor. At 7 P.M. the whole floor was covered and the liquid still continued to gush out; then it decreased and new spatter cones were built up with orifices by 9 P.M., from which jets of lava were occasionally thrown out.

The new lava lake exhibited during the evening the common phenomena so often described. Cracks formed in the dull crust, lava pushed out in sheets or tongues, plates of the crust turned up and sunk in the molten lake beneath. The illumination was often brilliant, and all the conditions combined to make the scene grand and impressive. On October 24th there was no flow; the floor was so solidified that the fracturing and extrusion of lava was rare and of small extent. At the blow hole there was frequently repeated the process of sealing up the orifice by viscous matter, then a bursting out, making a new hole, which would be sealed up again in an hour or two.

On the evening of the 25th the strong glow indicated action, and there was another thin flow over the sheet of the 23d. The spatter cone remained on the north side and no other vent could be seen. The action was that of sealing up and bursting again, without any discharge. On the 27th, just before daylight, a bright glow was noted over Halemaumau, which was occasioned by another thin flow.

November 8, 1902.—Charles R. Frazier.—Lake at bottom of pit very active.

When Hawaiian Hall of the Bishop Museum was planned I had reserved a suitable space in the centre for a relief plan of Kilauea, and as the place was now ready, I went to the crater with my assistant, W. A. Bryan, to collect the needed data. Both by many photographs of the outer walls, and barometric measurement of all undetermined heights, I collected considerable material, while Mr. Bryan made on the spot a small model in clay of the proposed relief, correcting it from many positions. The final plan now on exhibition is on a scale of 130 feet to the inch, and was constructed by Mr. Bryan with great care, and has met the approval of all scientific men who have

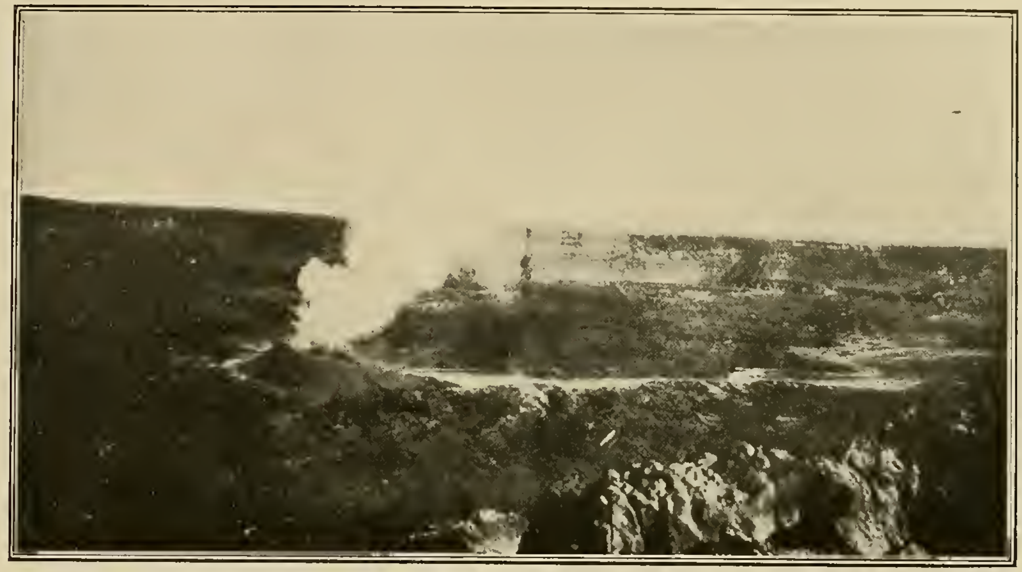


FIG. 125. ERUPTION OF 1903 BY DAY. C. BALDWIN.

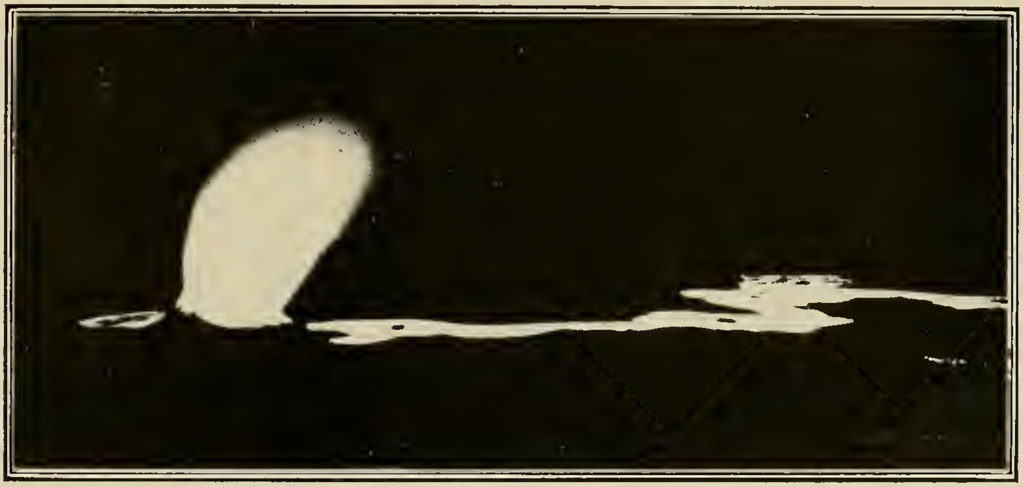


FIG. 126. ERUPTION OF 1903 BY NIGHT. C. BALDWIN.

seen it. Ten days were spent at the crater in this work, and the volcanic manifestations were not of special interest, as the pit remained quiet and mostly clear of smoke, giving us, except on rainy days, good views of the whole area, and permitting exploration around the pit, and on its lee side. In the finished model arrangements were made to remove the region around Halemaumau if at any time a marked change should take place, and substitute a remodelled portion in its place. Only the difficulty of finding place for so large a model has prevented the preparation of a similar model of Mokuaweoweo. One of Haleakala would also be desirable, but the surveys of that vast crater are not yet sufficient for the work of model making.

March 19, 1903. Professor J. C. Branner was at crater.

June 21, 1903. W. R. Castle.—The time has come when the United States Government might well reserve the whole region of Mokuaweoweo to the sea at Puna, a long, narrow strip to include Kilauea and the line of pit craters, a comparatively worthless strip of country commercially. It should also include the Koa tree moulds at Kuapaawela, where a forest of giant trees was surrounded by a deep flow of later age.

August 23, 1903. Clouds of smoke ascending from the pit, indicating a cessation of action.

October 6, 1903. St. Clair Bidgood.—The summit crater Mokuaweoweo broke out today at 12:45 P.M. December 8th activity ceased.

November 25, 1903. Halemaumau again in action, and a lake, forty by a hundred and twenty-five feet, formed early in the morning and remained active until January 10 of the next year.

Many people visited this eruption, and many reports were published,[127] but these being generally by inexperienced observers are somewhat in need of pruning. Still, certain interesting matters may be sifted from the mass, and the camera affords us (by the kindness of Mr. C. Baldwin) an indisputable testimony to at least one stage of the outbreak. We may select reports from parties reaching the summit from both sides of the mountain. Naturally the first party was from Hilo, and it left the Volcano House by the Kapapala route already described. Starting from Kapapala ranch in the morning on horses and mules, with pack animals and ample supplies, they reached the 10,000 feet level at 2 o'clock P.M., and camped until 7 A.M. the next day. The summit was reached at 2 P.M., and the temperature was reported at several degrees below zero. All were so affected by mountain sickness that, rolled in their blankets, they threw themselves on the cold lava at the brink, suffering severe pains in the head. Those who cared to look saw a small pool towards the northwest end of the main crater, north of the centre of activity of 1896. Over the rim of this pool, and, according to Mr. T. C. Ridgway, who left a plan in the Volcano House Record which is here reproduced (Fig. 127), the stream flowed northeast for more than a mile with a branch bending southward. The fountains which illumined the high column of vapor were confined to this lake, and the outpouring lavas made a cone as clearly shown in Mr. Baldwin's picture. The party left the crater the next morning at 7 o'clock, and by evening were at the Volcano House. One of the party declares that the roar of the "fire geysers sounded like the smashing of heavy seas against the rocks. The spouting columns of white-hot lava arose . . . . . . to heights of several hundred feet, and would fall back as blackened boulders and huge chunks of congealed cinder."

---

[127] Thrum's Annual, 1904, p. 163.

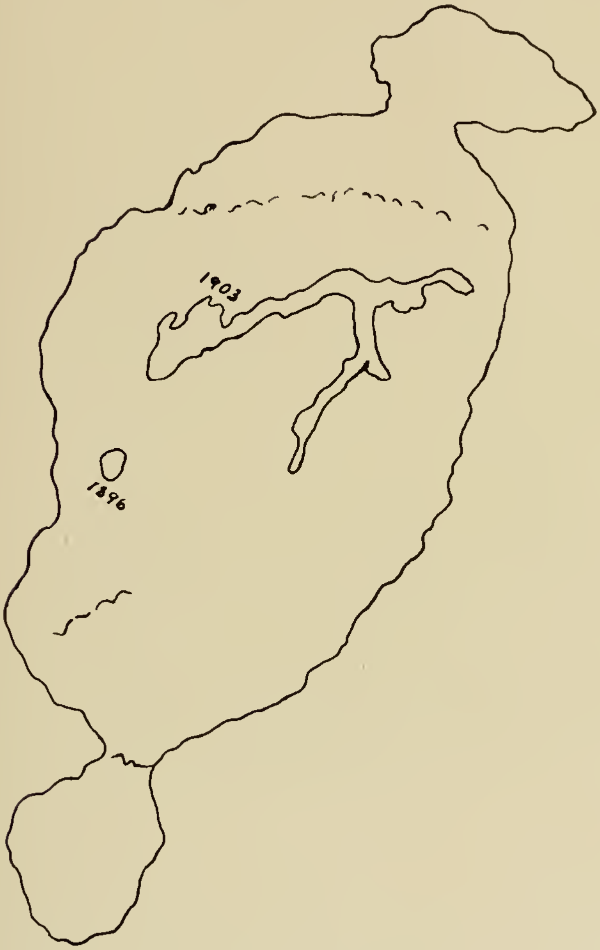


FIG. 127. MR. RIDGEWAY'S PLAN OF THE ERUPTION.

A party from Napoopoo were caught in a severe hailstorm and lost their way, reaching the summit after great hardships. "The sight was simply indescribable. Columns of fire from forty to a hundred feet were playing, now here, now there. We counted about thirty fountains [meaning such fountains as are common in Kilanea's pools]: one fully formed cone nearly seventy-five feet high in about the centre of the crater, and one forming a little to the southwest of it. There was smoke or steam everywhere in the crater, but the principal eruption was in a line running through the centre of the crater of Mokuaweoweo from the southeast to northwest."

Several of the party state that the entire crater floor was covered with molten lava, but others limit the lava to the stream already mentioned in the northern half of the crater. This party from Napoopoo had a bad time coming up, and had left some of their number in camp at the 11,000 feet level; after spending two hours and a half on the summit they returned rapidly to this camp. In the words of one of the party: "On arrival one of the guides who had remained with the sick one at camp had coffee ready for us, and horses saddled and packed; no time was lost, as we wished to make the edge of the woods before dark. We left the 11,000 level at 11:30 A.M. and proceeded downward at a brisk walk, the animals feeling very cold and eager to walk. Hardly had we descended a thousand feet when the sky darkened and a most terrific snow and electrical storm was upon us. The hail was so pelting and heavy that it hurt our hands, although we wore woolen gloves. The mules refused to move, and before many minutes the ground or lava was white with snow. The lightning was vivid and hissed dreadfully, followed almost instantly by tremendous thunder. We found no shelter, and were almost frozen stiff. On and on we rushed, and the lower we got the less of the storm we saw. Dangerous as the roads had become we made all possible speed. After an hour and a half the storm's fierceness was broken, and from there the homeward journey was uneventful. At the 8,000 feet level those affected by mountain sickness recovered. The down trip took exactly fourteen hours; no stops were made. We went from where we camped to Napoopoo, arriving in the morning at 1 A.M." This eruption was confined to the main crater and lasted two months, followed by a small flow from Pohaku o Hanalei.

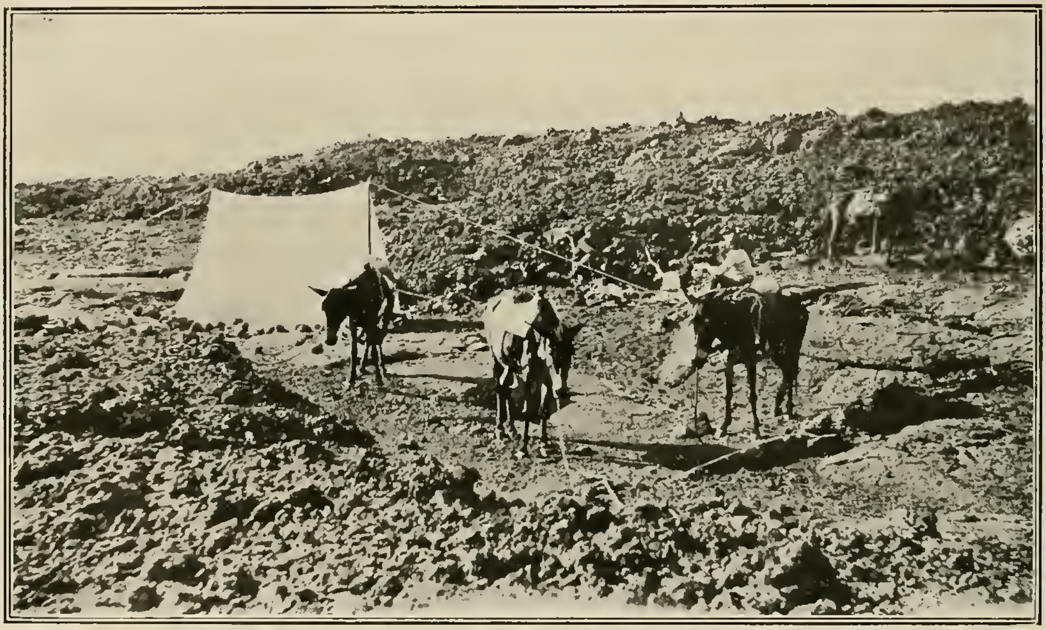


FIG. 128. CAMP ON THE EAST SIDE OF MOKUAWEOWEO, 1905. W. T. POPE.

To return to the Kilauea record:

November 25, 1903. St. Clair Bidgood.—Lake about 40×125 feet. Fountains playing continually and surface very active. Remained active until January 10, 1904.

February 13, 1904. J. B. Castle.—Crater inactive.

May 14, 1904. Bishop Restarick.—Crater quiet.

February 23, 1905. Demosthenes Lycurgus.—Fire at bottom of pit.

March 20, 1905. W. Williamson.—Fire at bottom.

May 1, 1905. L. A. Thurston.—Pit has filled up since November.

July 22-23, 1905. Professor W. T. Pope and party were on the summit of Mauna Loa. By his kindness I am enabled to present to my readers some of the good pictures he made on this trip. The view of the camp south of Pendulum Peak, and the one used by many parties from

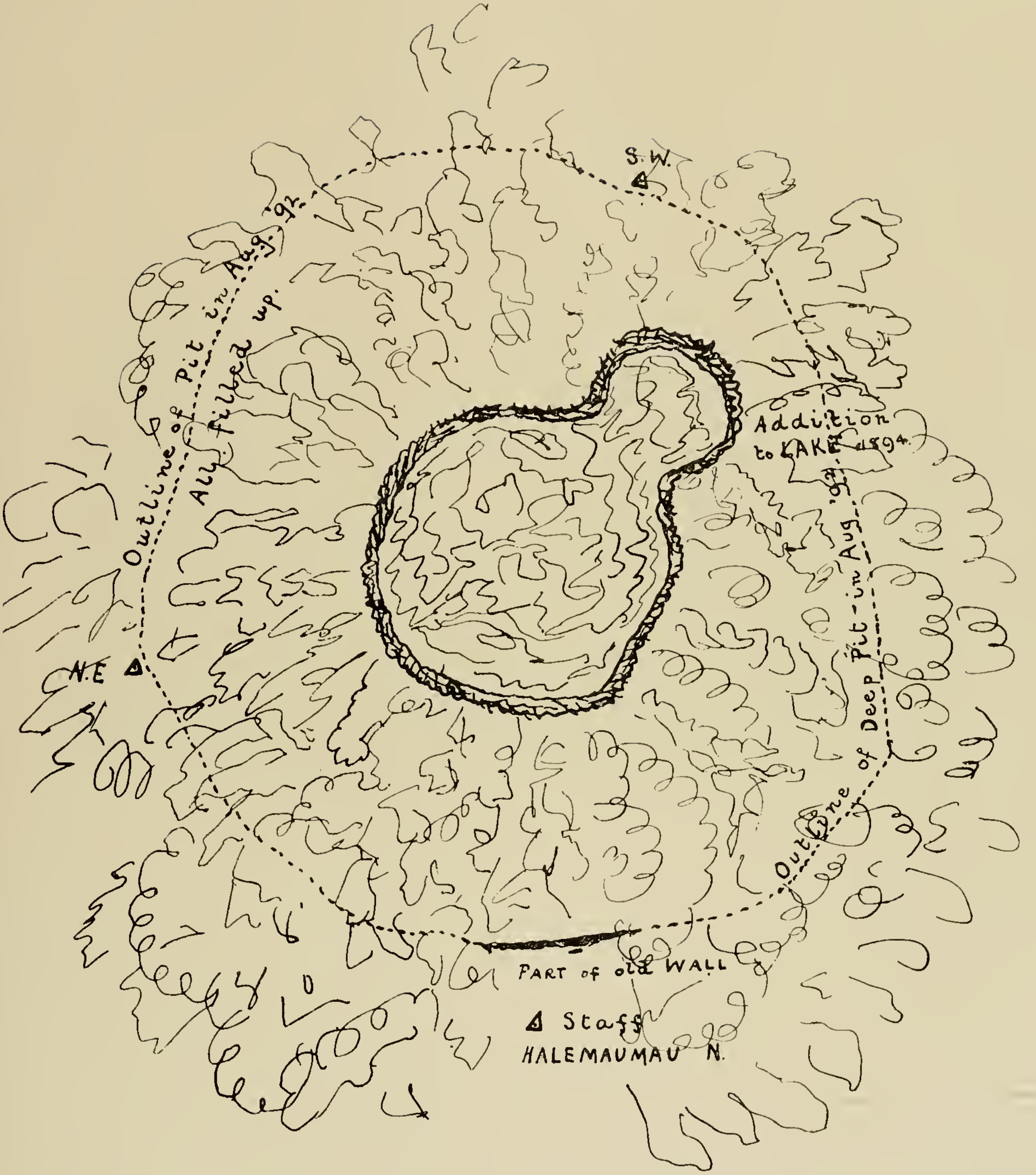

S.W.
Outline of Pit in Aug. '92.
All filled up.
Addition to LAKE 1894.
Outline of Deep Pit in Aug '92
N.E
Part of old WALL
Staff
HALEMAUMAU N.

FIG. 129. HALEMAUMAU IN DECEMBER, 1906. BALDWIN.

Kapapala, shows well the exceedingly rough nature of the surface. The outlook from the plateau (Fig. 130) gives some idea of the vast western wall and its nearly perpendicular surface, while the nearer view (Fig 131) of the eastern wall shows the layers and the talus, and also the fresh lava flows on the floor. The descent can be seen to be far more difficult than that into Kilauea. One can easily imagine, while looking at these pictures, the disgust of the botanist Douglas, who saw nothing worthy the attention of a naturalist!

September 16, 1905. L. A. Thurston.—Little sulphur in smoke: no noise [in Kilauea].

December 15, 1905. Clifton H. Tracy.—The volcano is more active than for three months, although the fire is still confined to two cones in the southwest.

January 22, 1906. A. Loebenstein measured the depth of the pit at 576.9 feet.

December 2, 1906. E. D. Baldwin.—Fire visible in pit after nearly a year of inactivity.

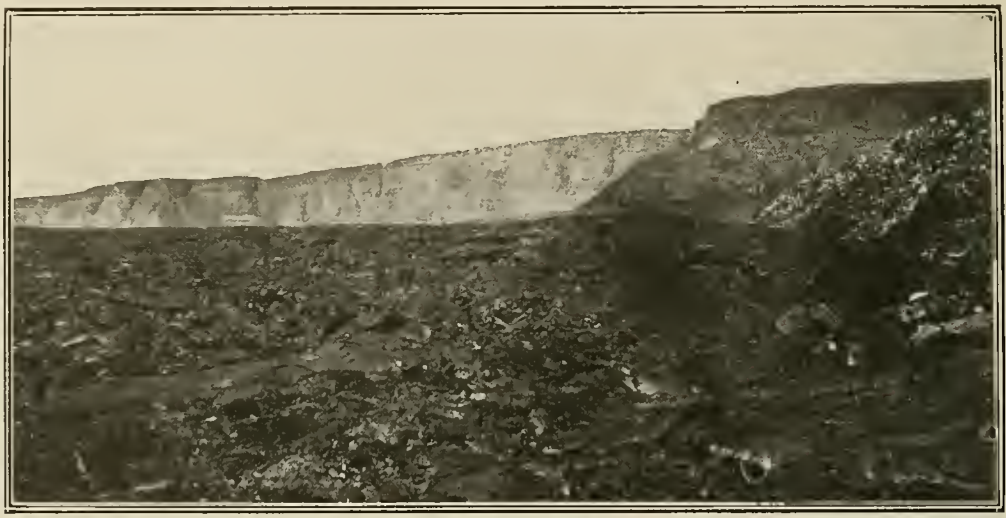


FIG. 130. WESTERN WALL FROM PLATEAU. W. T. POPE.

January 9, 1907. Eruption of Mauna Loa. After a few slight earthquakes that were felt, not all over Hawaii, but in a few places only, about midnight on the ninth of January a bright light appeared on the summit of Mauna Loa, as it seemed at first, and it was some time before the true locality of the outbreak was determined. This proved to be far below the summit on the southern slope of the mountain, in the Kahuku region, already the seat of the eruptions of 1867 and 1887. As may be seen on the map, its source was higher up than either of these flows, and about half way down it divided into two nearly equal streams with a small and rather unimportant one between these and nearer the westerly one. Many visited this eruption, but there was little to relate differing from its predecessors. One or two points, however, appear in the summary given[128] that may well be reproduced here:—

> So violent was the activity, and so liquid the flow of pahoehoe lava that the stream reached and crossed the Government road on the Kona side of the lava flow of 1887 in two days, advancing in places at the rate of seven miles an hour, destroying the telephone lines and stopping traffic for a

---

[127] Thrum's Annual, 1898, p. 131.

short time. By the 16th it had extended over thirty-five miles of waste land, and in a moving mass fifteen feet high, and half a mile wide, changed in character to aa, it kept onward at the rate of thirty feet an hour, shortly afterwards subsiding, but only to give way to a new flow which also crossed the road and seemed to have come from the same source, though at a much lower elevation.

The second flow was merely a branch of the first stream, and, like that, was, at its separation at the Kamoalaala hill, pahoehoe; but as it advanced and cooled it assumed the aa form, and this was the nature of both branches as they crossed the road, showing a depth of fifteen to thirty feet, which was increased at the end, which of both streams was some three miles from the sea, to over fifty feet. A lake some 800 feet in diameter formed in the course of the flow, and a party of prominent citizens managed to get a clear view of this lake, and their description is as follows:

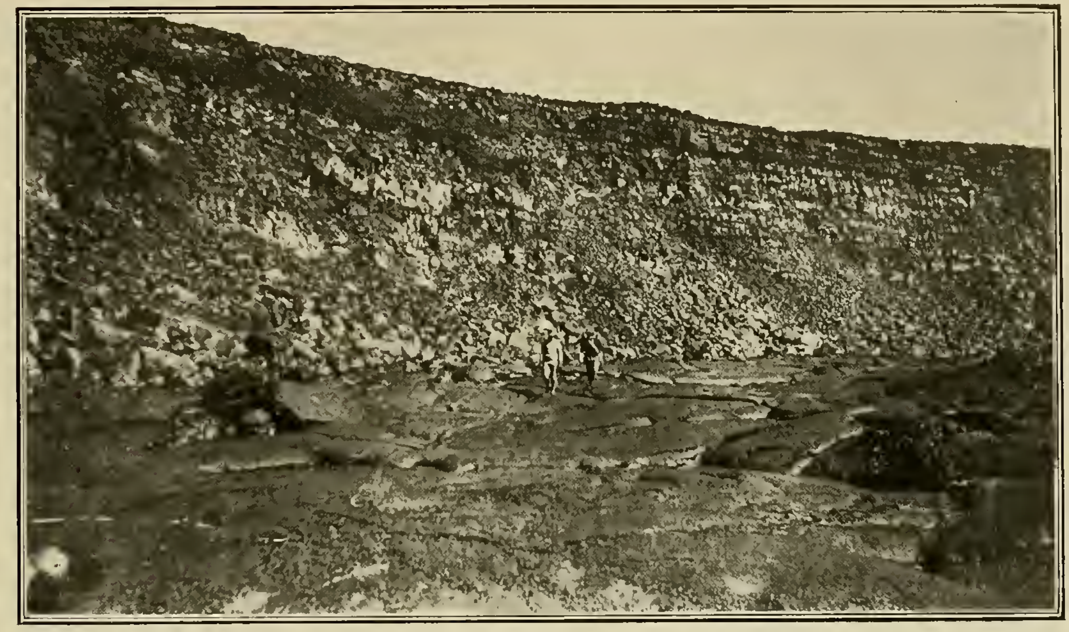


FIG. 131. AT THE FOOT OF THE WALL. W. T. POPE.

> [There were] two great holes in the bluff out of which two streams of lava were running. A little way from the shore was a fountain that kept shooting hot lava fifty or sixty feet into the air. Occasionally the lake would cool in spots, making little black islands, and then a wave of molten lava would rush across the surface and bury them. This continually changing scene entranced the observers for some three or four hours. [It is noteworthy that this temporary lake exhibited the motions of the pools in the crater of Halemaumau, indicating the origin of fountains, etc., to subsist in the lava stream itself.] A stream of lava ran between the party and the lake; yet, desiring a closer view, they crossed the flow, which was all aglow underneath, and got right to the base of the lake which had built itself up about sixty feet. Looking up a glowing hill to the rim of the lake did not give assurance of safety, so they retreated, then rested for the night, taking hour watches, lest the walls of the lake give way and rush down the hill, which sight, should it occur, they desired to see. On January 24th the flow ceased, but activity at the source continued for some time.

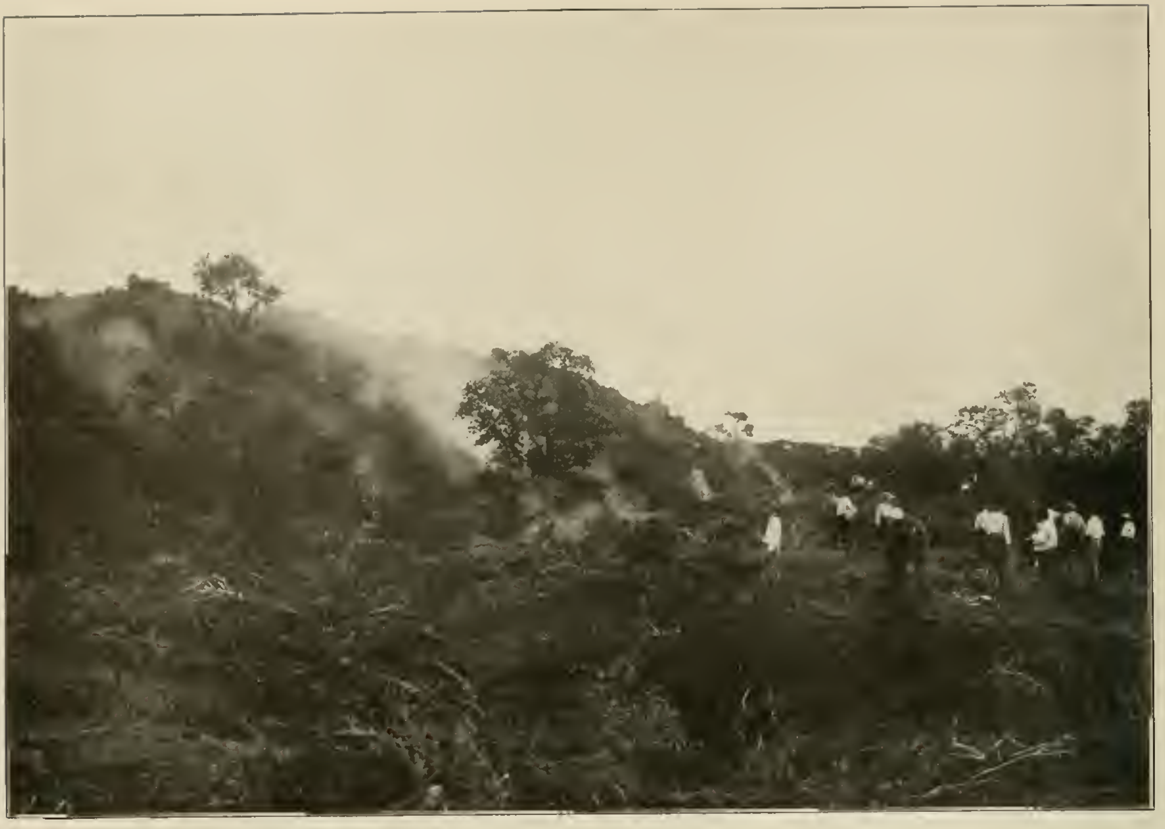


FIG. 132. MOVING MASS OF AA IN FLOW OF 1907. PERKINS.

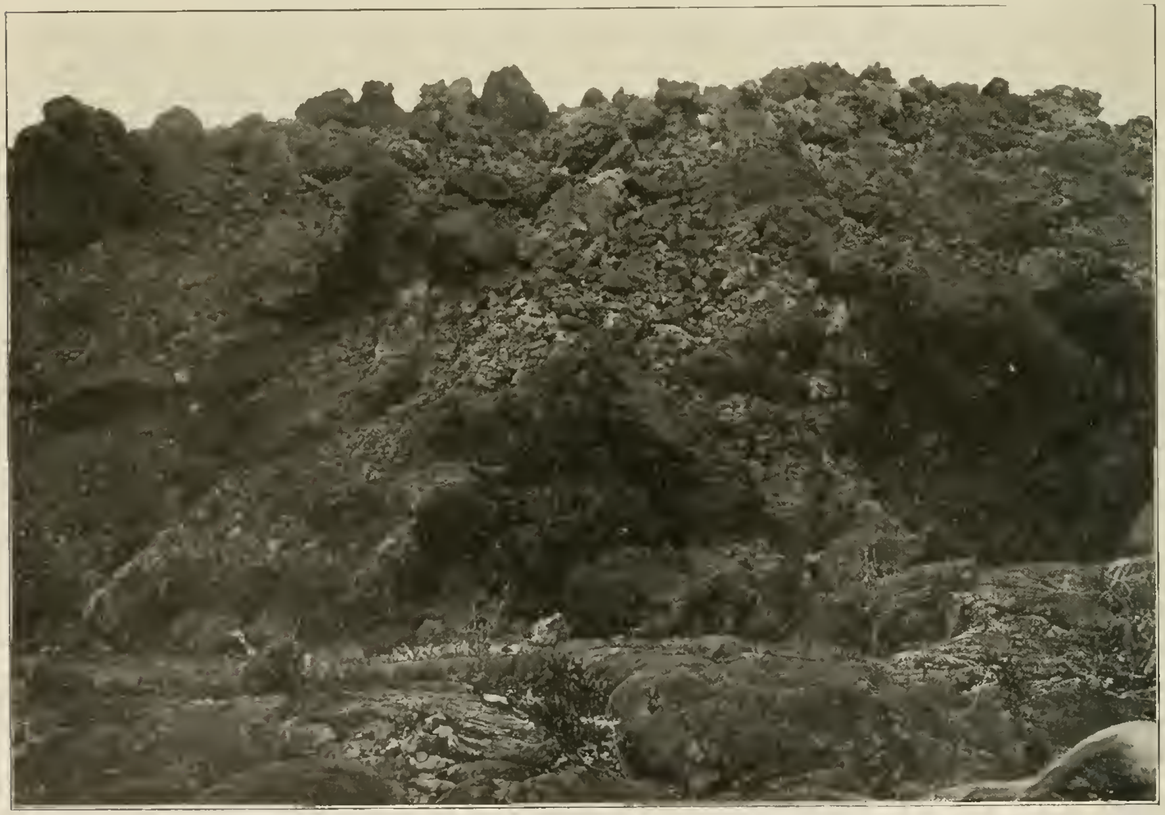


FIG. 133. FRONT OF THE AA FLOW, 1907. PERKINS.

This lake finally broke through its encircling walls and followed the rest of the flow down the hill. The lava where the flow crossed the road shows many very brilliant particles of olivine, and at the time of eruption unusual quantities of sulphur were noticed by many visitors. Kilauea, which had been slumbering, again roused into action about the time that this Mauna Loa eruption ceased. We take up the Volcano House Register again.

January 23, 1907. Rev. E. W. Thwing.—The lake was more active, and steadily rising.

April 12, 1907. Immanuel Friedländer found little fire.

May 12, 1907. Demosthenes Lycurgus.—After some days quietness in the crater, fires returned last night; cone on north side of pit quite busy, spurting every few minutes to a height of fifty to sixty feet. A stream of lava from above flowed almost around the whole floor of the pit. May 28: active and the "hole" that sank some weeks ago is rapidly filling up.

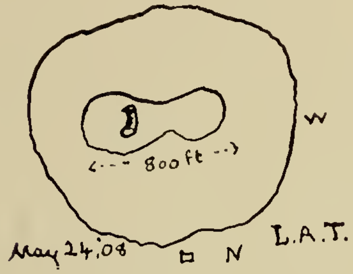


FIG. 134. LAKE, MAY 24, 1908.

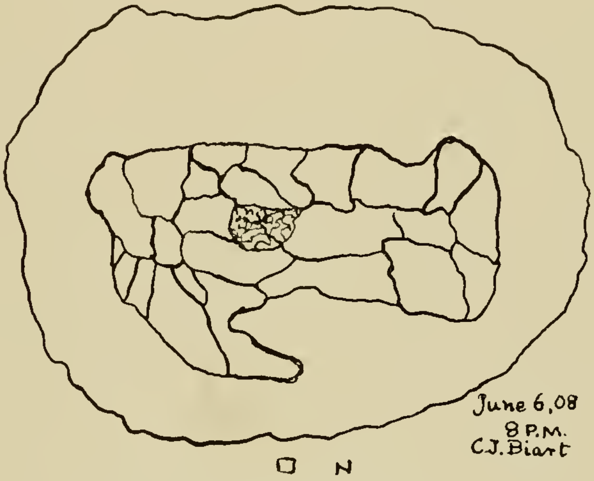


FIG. 135. LAKE, JUNE 6, 1908.

July 10. Lycurgus.—A lake of fire seventy-five feet in diameter.

July 25. Lycurgus.—Fire returned, but in small quantity.

November 20. Lycurgus.—The volcano became active again after a quietness of seven months. The whole pit was lighted up. The next day those who went down found only a little cone on the Volcano House side of the pit, with flames of fire, but no lava flows or fountains. In the evening the fires disappeared again.

December 7, 1907. W. A. Wall, Surveyor.—Found the pit 450 feet deep to a contraction only 200 feet in diameter, and this, a little lower down, showed fire about 40 feet across.

December 16, 1907. W. B. Henshall.—Quite active.

May 24, 1908. L. A. Thurston.—I estimate the pit to be 200 feet in depth, and the lake 800×400 feet in the form [shown in diagram, Fig. 134] with an island in the middle of the larger end. There is more activity than at any time since the breakdown, March 11, 1894.

June 6, 1908. C. J. Biart made a sketch of the lake at 8 o'clock P.M. (shown in Fig. 135).

June 21, 1908. L. A. Thurston.—The depth of the pit is about the same as on May 24th last, but the size of the lake has increased about fifty per cent. The diagram by C. J. Biart fairly represents it.

1908

Early in September, 1908, Halemaumau, which now was a single pit on the top, or near it, of the huge dome of lava which forms the floor of Kilauea—about four hundred feet above the general floor of Kilauea in 1864, when the writer first visited and surveyed the crater—had filled with lava to within a convenient point for observation from the highest part of the rim, and not a few visitors made photographs of the pit both by day and night, some of which I am privileged to use for the clearer understanding of the condition. Never before perhaps have so many night scenes been secured, and those I shall present will give, so far as black and white can give, some idea of the wierd appearance of the molten lava as seen through the opening cracks, often enough described, but hard to understand from mere words.

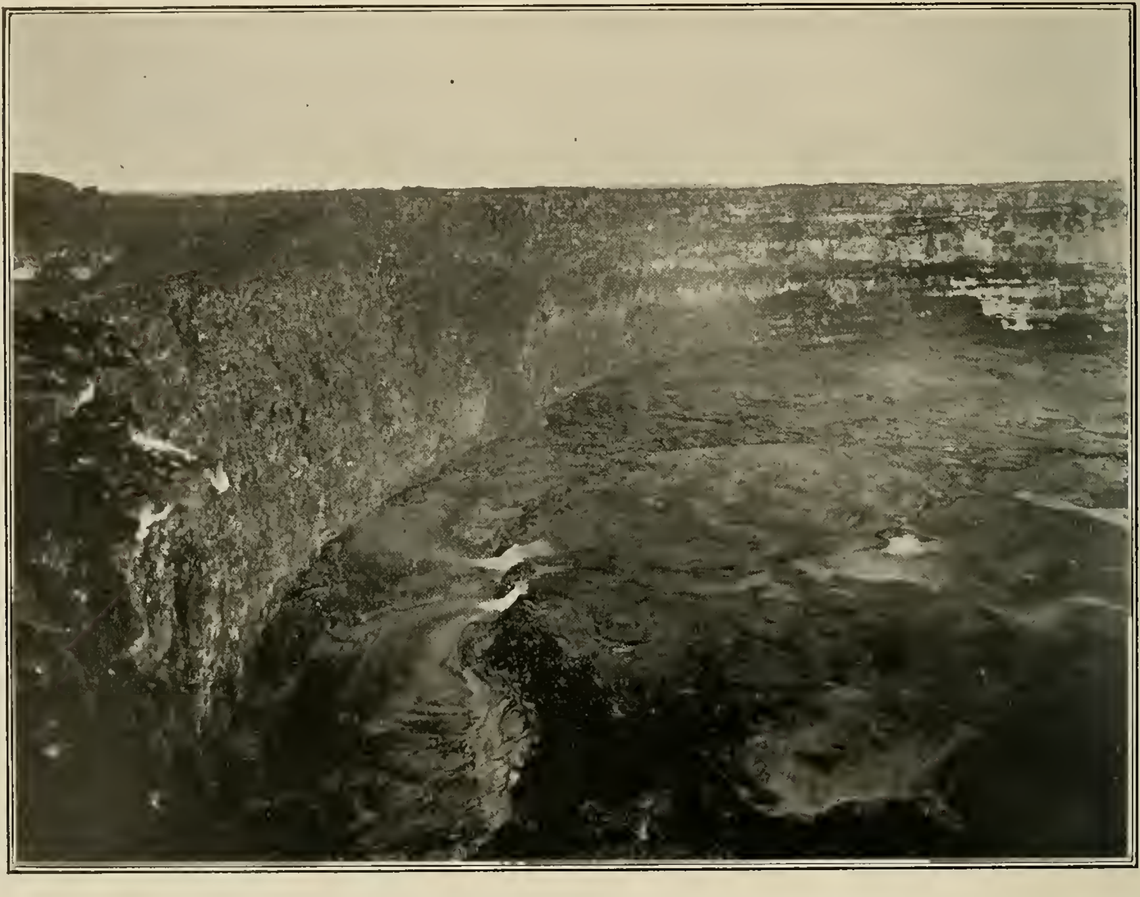


FIG. 136. HALEMAUMAU IN AUGUST, 1908. PERKINS.

The process of filling had been a slow one, for the pit left after the last emptying was a very deep one. For a long time there had been no fire (or molten lava) in the visible crater; walls of cracked and irregularly disposed rock supported a black, uneven, and much cracked rim, which seemed in places ready to fall, and generally projected over the abyss. When the lava again appeared it was like a small spring of tar at the bottom, which was at least six hundred feet below the average rim. So far below the spectator that it seemed of little importance or interest, but it was the sign of returning action, and soon the molten matter accumulated in a little pool whose surface was broken at intervals by the spouting lava in the way familiar to all who have seen Kilauea in action. The spring which supplied the vast reservoir was intermittent, and the surface of the pool rose slowly and irregularly. As it rose, however, the action increased, as is usual, and all through August the height of the lava column, at least fifty feet above the base of the dome, was critical. How much longer could the walls of Kilauea withstand the pressure? Fountains of lava frequently spouted, and as many as fourteen were counted in a single evening, the glow from the pit illumi-

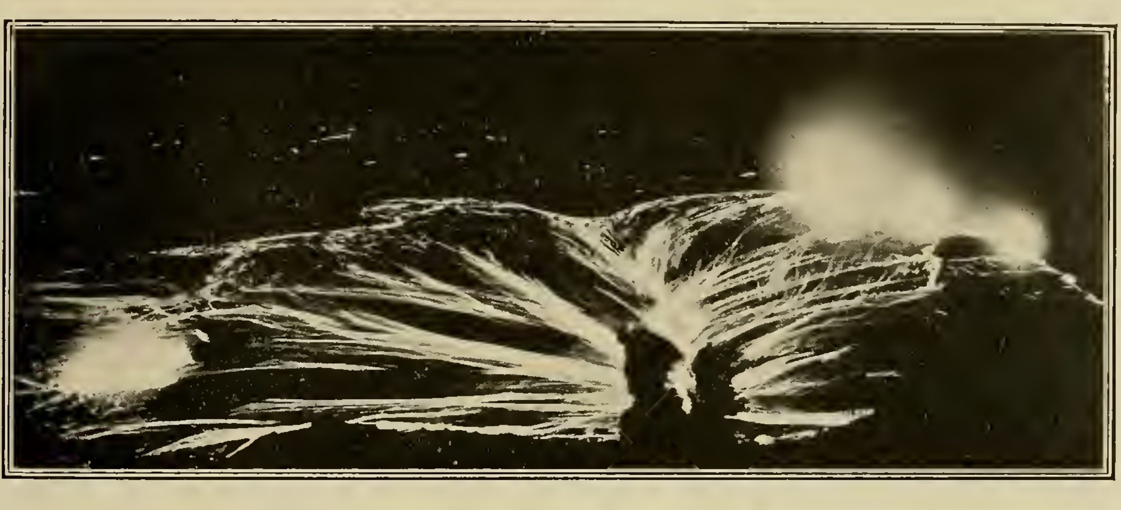


FIG. 137. SURFACE OF HALEMAUMAU BY NIGHT. PERKINS.

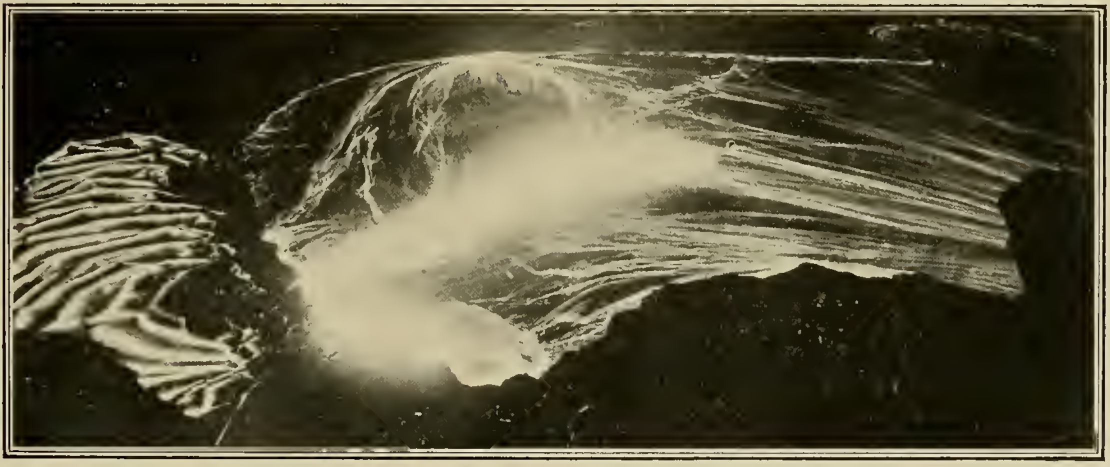


FIG. 138. SURFACE OF HALEMAUMAU BY NIGHT. PERKINS.

nating the whole crater so that lanterns were hardly needed for the parties who visited the "everlasting house of Pele" by night. While the action was distributed over the whole surface of the pool, some of the fountains seemed to have a definite position which they retained for days; such was a vigorous one in the eastern half of the pool which hardly varied its place during the two weeks of our stay at the crater. It was like the "Old Faithful" of previous years, although not in the same place. Under the east bank the floor was at times at a lower level than the general surface of the pool, which seemed to form a rim or dam there, and thus repeat in a measure the process so often seen in Kilauea, and shown especially in Silva's remarkable photograph (Pl. L). As seen in Perkins' view of the east end (Fig. 136), two falls of molten lava mark the raised wall, and the reader will bear in mind that much of the surface to the right is red-hot and subject to the breaking up and gushing forth of white-hot lava. By night the scene is by no means so tame as it appears in the photograph, where the red-hot lava is no brighter than the black lava of the walls. Mr. Perkins has caught the effect better than any others whose work I have seen (Figs. 137 and 138), and one can see the bright lava drawn out from the cracks, a process which gives the impression of currents flowing in a definite direction. The light, cloud-like effects are from the brightly illuminated gases, and it will be noted how local the escape of these gases is; not a sign of any such emission over most of the exposed surface. In Mr. Thrum's picture (Fig. 140) a long crack is seen from which the lava seems to flow toward the spectator; and this picture also shows how the action was spread over the whole surface of the pool. In Fig. 141 are seen the tiny watch-fires which are so beautiful a feature of the night view. These are often so small and so constant that they are like lanterns placed as danger signals.[128]

A view from the northwest bank of Halemaumau, taken at the same visit (as Fig. 136) by Mr. Perkins, shows the shelter hut whence the best views have been obtained a little to the left of the centre of the picture (Fig. 139), and it also shows the irregular outline of the pit and the varying level of its walls. From this it will be seen that the rim where the outlook is built was not at that time undercut, but seems as solid and safe as any part, while the impression given, especially at night, is of an overhanging shelf. Another curious fact is to be seen in this capital picture: while the structure of the rim in the foreground, where it is lowest, gives the impression (and a correct one) that the pool had overflowed here, yet on the much higher part of the rim farther to the left the same formation is found, and certainly the pool could not have overflowed all round simultaneously. Has the higher edge been raised or the lower edge been depressed? If so where are the faults in the wall?

---

[128] The walls of Halemaumau may be shown in these night views, when the illumination from the lava is insufficient, by a short exposure by daylight, and, leaving the camera undisturbed, repeating the exposure by night.

On Friday, September 4th, in the early afternoon the fountains ceased to play, and soon the subsidence of the pool began. Parties coming up from the pit at dusk reported the fall at several hundred feet, but the light as seen from the Volcano House and reflected on passing clouds did not seem less than it had been when darkness came on. Mr. C. B. Thompson, Mr. Chas. N. Forbes and myself at once started for the Halemaumau. The earth light was still sufficient to show the path. All over the surface of the pool, which had fallen perhaps a hundred feet generally, but much lower on the northern side under the observation hut, were bright lights, and most of these remained stationary during our visit.

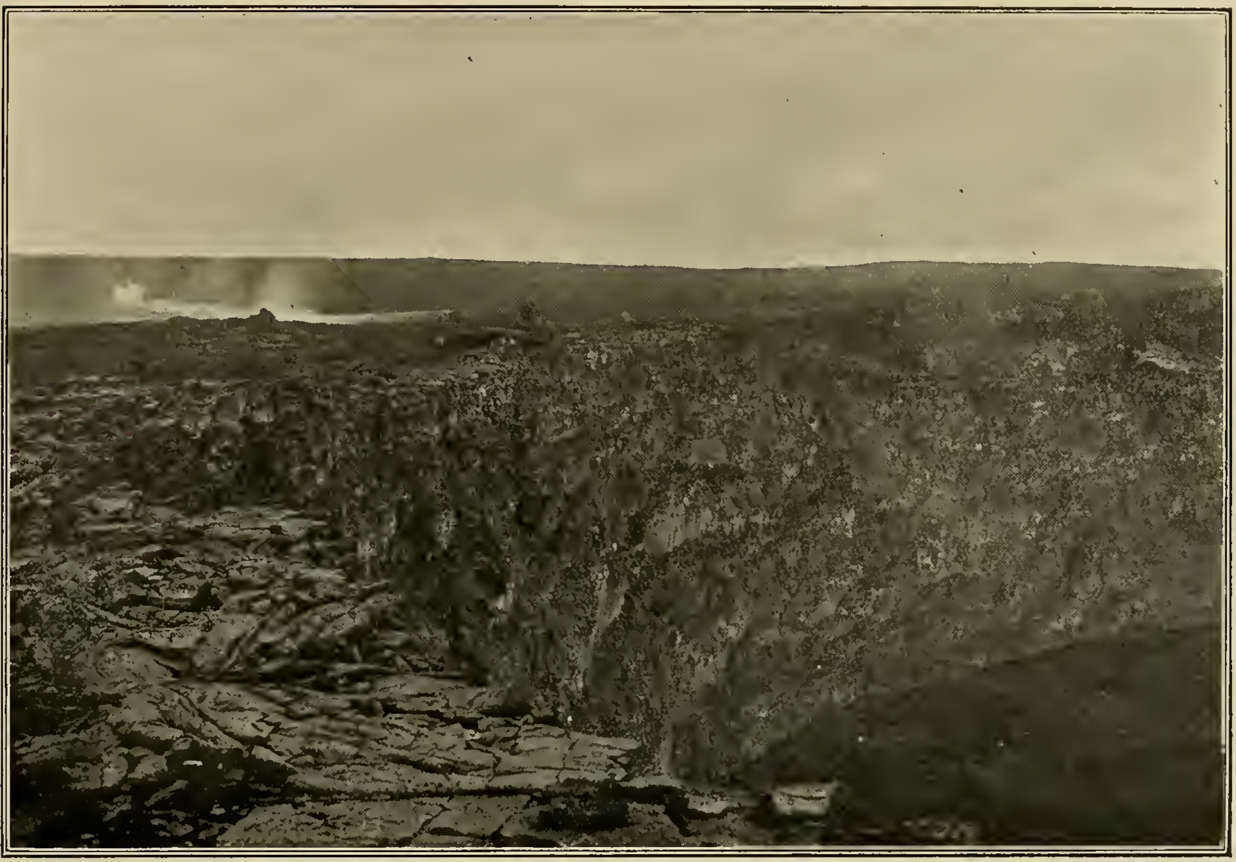


FIG. 139. HALEMAUMAU FROM THE NORTHWEST IN 1908. PERKINS.

In the centre of the pit was a curious break running east and west, at the edge of which was a vertical slab of lava, semicircular in form, resembling half a mill-stone, and other slabs continued the wall for some distance. Over these fell a cascade of lava in a condition I had never before seen; its particles seemed to be in a state of mutual repulsion, and although white-hot, fell through the central hole of the "millstone" as meal. There seemed absolutely no cohesion, no signs of plasticity in the molten lava. There seemed to have come a spirit of disassociation into the pit, and the white hot particles of lava seemed in haste to get as far from each other as possible. They scattered like a flock of frightened birds. Another puzzle added to the lengthening list!

The descending lava had left pockets of molten rock in the walls; these emptied themselves on to the sinking crust with spatters and flashes. Masses of lava had also been left adhering to the loose walls, and one of these, apparently weighing twenty tons, broke from its place, sliding down a path marked by a trail of white-hot lava so brilliant as to light up the clouds above the crater. Before it had fallen fifty feet the huge boulder broke in two, displaying its interior, brilliant as an arc light, and then began the utter disintegration of the mass as it thundered down, the bright particles scattering as did the "meal." All the while the danger signals burned here and there over the black crust. Here and there would come a break, and the old movement of apparently viscid lava was seen for a moment, but it soon broke up. Less fleeting was a huge interrogation mark drawn in fire on the western side. What, indeed, did it all mean? And the question was unanswered when at last the burning mark had faded.

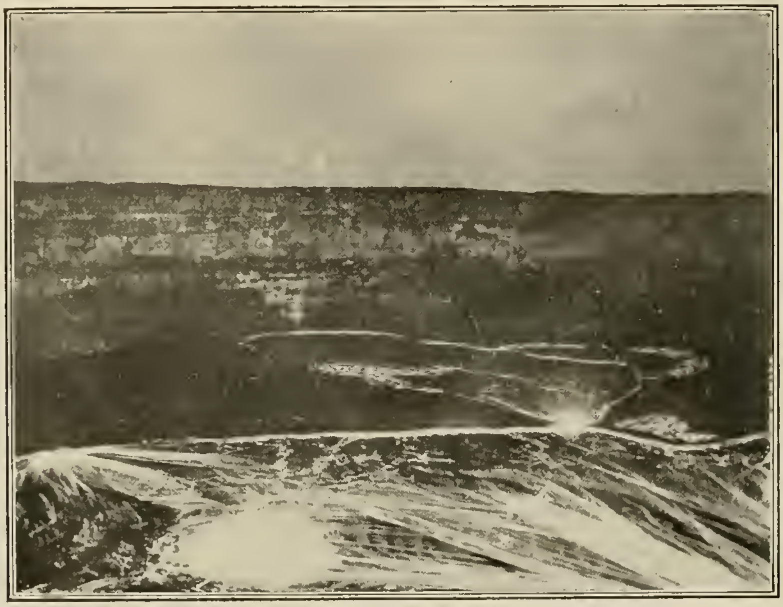


FIG. 140. HALEMAUMAU BEFORE THE BREAK. D. F. THRUM.

Directly under the cliff on which the observation hut stands was the deepest hole into which all the incandescent meal of this infernal mill was sinking down; even had it been safe to approach the edge to get a good view into the abyss, the heat was prohibitory, and while the mill-stone in the midst still poured its grist down the slope, the danger signals grew dimmer, and here one went out in the darkness, and no lamplighter was at hand to renew it; the walls seemed to have shaken down all their loose rocks, the crust was no longer breaking, and the glory of the scene had ended. We could still see light from Halemaumau when we reached the Volcano House, but how dim compared with that which had brightened the whole crater the night before! Saturday night the pit was totally dark, no sign of fire could be seen from the house. All seemed over, but the emptying of the pit had stopped, and that was an indication that soon the action would be renewed, and no such long period of inactivity as had been the rule for many recent years was to be expected, and on the third day the lava rose again with great violence, throwing spatters above the rim of the crater. Nor was this a mere spasmodic action, for the renewed action has continued to the present writing.

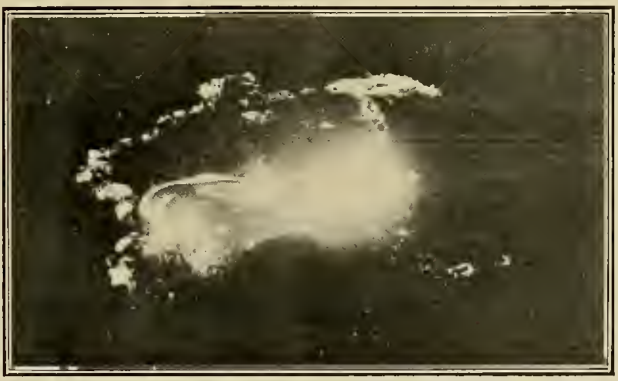


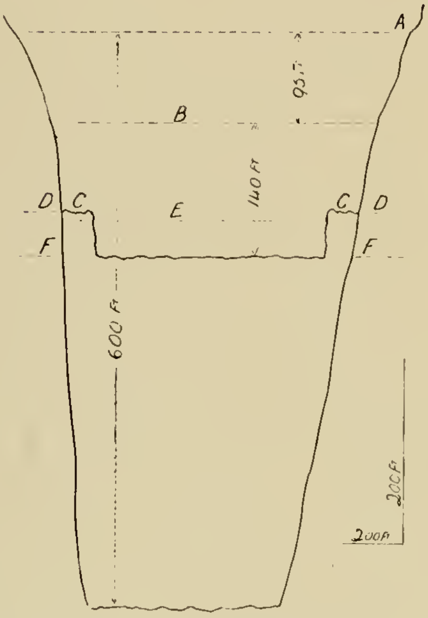
FIG. 141. NIGHT VIEW OF HALEMAUMAU, AUGUST, 1909. MISS M. REED.

March 13, 1909. At Hilo, about 3:30 A.M., two sharp shocks of earthquake, separated by a slight interval. Pictures were swung, and light objects were upset. March 14, three slight shocks in the forenoon, and another in the evening.

Thus far this informal History was approved and ordered printed March 26, 1909, but a visit to the Volcano of Kilauea on October 7th, 1909, undertaken to settle certain doubts in the record, determined me to add to the record herein printed such observations as have been placed in the Volcano House Register during the interval caused by the unexpected delay in the printing. I am the more ready to do this as this volcano has developed in the meantime an action to me new and very interesting; and also that the volcano has been visited by the very distinguished English vulcanologist Dr. Tempest Anderson of York, and the well-known professors in the Massachusetts Institute of Technology, T. A. Jaggar, Jr., and R. A. Daly, the last two interested in the establishment of a permanent observatory at Kilauea, a result so ardently hoped for many years and frequently referred to in these pages.

After the breakdown of September 4th, the lava soon returned to Halemaumau, and the Register resumes the notes:—

December 12, 1908. E. D. Baldwin.—Lava returned September 7th, and in two hours was within 150 feet of the spot whence it fell September 4th. According to the accounts the lake rose and fell spasmodically after the 7th, and during some time in October had reached a place one hundred feet below its elevation on the 4th, only to fall again as evidenced by the present black ledge some forty-five feet higher than the level of the lava as it now stands.



A. Observation point 279 ft. below V. H. floor.
B. Level of lava September 4, 1908.
C. Black ledge formed in October, 1908.
D. Level July 26, 1908.
E. Level October 7, 1909.
F. Level December 21, 1908.

FIG. 142. SECTION OF PIT. BALDWIN.

During November and December the lake has assumed again its steady filling action, and at this date [Dec. 21, 1908] is 235 feet below the point of observation. Two nights ago the lake was nearly 250 feet deep.... The small rim of the lake is constantly being built up, and many small flows pour over the sides; last evening within three hours there were some eight overflows, many reaching the walls of the pit. There were three other centres of action at the rim of the lake where the continuous splashes of the fountains have formed spatter cones; one at the southwest corner, another at the north side, and the third, a heavy moving fountain, at the east corner....Old Faithful was still in its old position, but only bubbling up every few minutes.

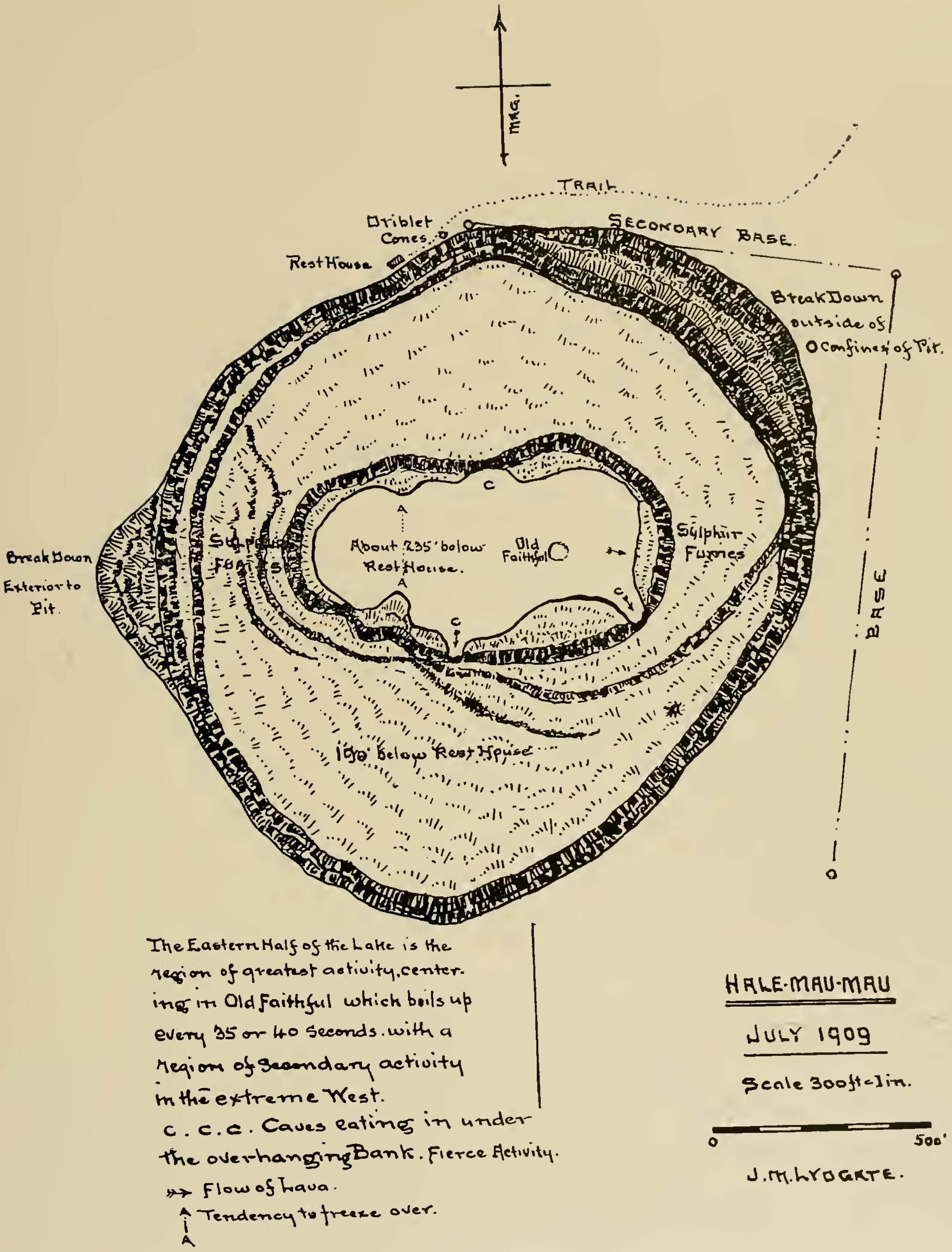
Mr. Baldwin also speaks of "traveling fountains" on July 26th, when Old Faithful started traveling in a westerly direction, followed quickly by another great fountain, until there were at one time four or five of these curious fountains. Some of these struck the shore under the observation point with great fury, splashing over the bank. I shall describe these more fully when I come to my own visit.

April 7, 1909. Professor T. A. Jaggar, Jr., records temperature of steam cracks. As his visit to these Islands was to ascertain the desirability of establishing such an observatory as the author has repeatedly advocated, he will doubtless publish his report, which will be more interesting than any such brief quotations of his recorded or spoken results. Soon after his visit, Dr. Tempest Anderson arrived at Kilauea, and after a brief visit joined the author in a hurried trip to the crater of Haleakala on Maui, where we camped in the crater two thousand feet below the rim, which rises some ten thousand feet above the sea. In the bottom are many cinder cones, some a thousand feet high, and of beautiful regularity; the sides often dotted with the beautiful "Silver-sword plant" (*Argyroxiphium sandwicense*), and the record of their eruption accentuated by volcanic bombs of beautiful regularity and divergent size, from a few inches to several feet in diameter. These bombs, so abundant here, are rare on the other Hawaiian volcanoes. Dr. Anderson took many photographs which it is to be hoped he will publish, for his great skill in this work was supplemented by very favorable weather. From Maui he went directly back to Kilauea, and has made the following record in the Register:

July 11, 1909. Dr. Tempest Anderson.—I have been here over three weeks at intervals during the last month. The place grows upon me, and the Volcano increases in interest. It is different from anything I have seen in the Old World, the West Indies, or in Central America. There one sees volcanoes building up piles of ashes and lava by explosions and outflow. Here explosion is subordinate, while there goes on also a process of solution and undermining which at present is more active than the building up. This is really the most striking difference noticeable. Beyond this the steadiness and restrained activity of Kilauea is remarkable. In regularity Stromboli in Europe compares; but in its case activity takes the form of frequent small explosions instead of a steady flow. The volcano I have seen most strictly comparable is Matavanu, that broke out in 1905 in Savaii, Samoa; in that case a river of molten lava flows in the bottom of the crater, enters a tunnel and runs underground several miles to the sea, into which it flows visibly by many changing mouths with the formation of vast clouds of steam. Matavanu, therefore, is certainly a river, while Kilauea may be either a river or a boiling pot. Characteristic of this whole region, and unknown to me elsewhere, are the pit craters so frequent here, and of which Kilauea and the crater of Mauna Loa [Mokuaweoweo] are prominent examples.

July 5-14, 1909. Rev. J. M. Lydgate made the plan on the opposite page; it will be noticed that the lava pool was at that time confined to a depression in the floor of the pit. Mr. Lydgate disclaims great accuracy, but his plan is substantially correct.

July 5-14, 1909. Miss M. E. Haskell.—During the first half of July the southeast part of the crater was clear enough of fumes for a descent. For additional data for the map [p. 219] a descent was made by Mr. J. M. Lydgate, with Prof. R. A. Daly, of the Massachusetts Institute of Technology, and Miss M. E. Haskell, of Boston. To the east of the Rest House, at the west end of the "Fallen-in area outlying crater," the descent began. In the external wall of the crater a cave was found five feet high by about eight by four or six, with stalactited roof and walls. The stalactites were of lava a finger-length or less, crusted with delicate white, tasteless crystals, some of which Mr. Daly collected for analysis. On the floor a white crystalline powder, with a soda taste, lay thick in patches; also collected for analysis. At the eastern end of the fallen area a rope was used for thirty feet of the descent to the first bench. Thence the trail is marked on the map. Some of the white stains conspicuous on the precipitous walls on the south side from the Rest House and elsewhere were examined and found to consist of crystals similar in appearance to those in the cave. Fallen boulders from these walls were also whitened with the crystals in spots. The floor of the first and second benches is as chaotically upheaved as the roughest part of Kilauea the great. One pile, visible from the crater top, is like a spatter cone. The floor of the last bench, 49 feet above the molten lava, is covered with a crust but a few months old and comparatively smooth. Fumes all along the route were much lighter than their appearance from above led us to expect, and the last bench was quite clear. On July 19th, part of this bench above the southwest cave fell in and closed the cave, and on the first and second benches fumaroles opened near the trail and made descent impossible.


MAG.
TRAIL
Driblet Cones
Rest House
Secondary Base
Break Down outside of Confines of Pit.
Break Down Exterior to Pit.
Sulphur Fumes
About 235' below Rest House.
A
A
C
C
C
Old Faithful
Sulphur Fumes
170' below Rest House
BASE
HALE-MAU-MAU
JULY 1909
Scale 300ft=1in.
0
500'
J.M.LYDGATE.

The Eastern Half of the Lake is the region of greatest activity, centering in Old Faithful which boils up every 35 or 40 seconds. with a region of Secondary activity in the extreme West.

c. c. c. Caves eating in under the overhanging Bank. Fierce Activity.

»» Flow of Lava.

A↑A Tendency to freeze over.

FIG. 143. PLAN OF HALEMAUMAU IN JULY, 1909.

Nevertheless some rash people ventured down at a time when the fumes were less abundant, and were there photographed by Mr. Moses, a photographer of Hilo.

In approaching the crater on the evening of October 6th, a bright glow was seen over the tree tops as the gloaming came on, and when we came out on the bank before the Volcano House the *beauty* of Kilauea appealed to me as never before. The whole diameter of Halemaumau was lighted up with a clear and almost uniform light, while from the central third arose an ever-changing and exquisitely graceful column to the height of many hundred feet, then expanding into the usual overhanging cloud. This column was by no means smoke, but a thin vapor only dense enough to reflect the color of the boiling lava below, and this vapor was controlled by constantly changing currents or intermittent supplies to spread and contract, curl and twist into most beautiful and attractive shapes. Not long, however, did the exhibition present itself, for the mists came between us and the pit like an old horn lantern, and we saw only the general glow all that night (October 6th). In the morning there was only the thin smoke coming irregularly from the whole surface of Halemaumau, but thicker and whiter than the abundant steam that arose from many parts of the main crater bottom as well as from the perennial cracks on the upper banks, for it had rained abundantly during the night.

I went early down into the crater to avoid company, for there is to me a solemn feeling of exhilaration in this grand temple of the living God that cannot be shared with strangers. At the very beginning of the descent my old friends the *elepaios* came flying to see, in their curiosity, who was the intruder, and they seemed almost to welcome me in their sweet notes. But once on the crater floor and the stillness was complete, even the breezes were silent, it seemed out of tune to break it with the crunch of one's tread on the lava. I paused on the bridge over the great crack and distinctly heard the dropping, on the deep bottom of the water resulting from last night's rain; the water at this end of the path made more noise than the fire at the other. As I approached the pit I turned to the left and came upon the brink where the downfall of the wall had occurred, so that only two-thirds of the pool could be seen, and little of the heat felt. It was well not to see the whole at once. Strangely it was not the wonderful cauldron of boiling lava that first caught my attention. On the high western wall that faced me was an opening, as the mouth of a tunnel, half way up the almost perpendicular wall. It was very regular and apparently about ten feet high and twelve feet wide. That was on a part of the wall exposed during my previous visit about a year ago, but it was not there then. Its black mouth indicated some depth, but although the sun was behind me I could see but a very little way in, and this was the sort of duct I had always imagined the pit would disclose if emptied; and yet, I had repeatedly seen the empty pit and never a conduit of such size, if indeed any, that could be considered passages for the retreating lava while the pit was emptying itself.

On the outer walls of the pit was the line distinctly marking the surface before the fall of September 4th of last year; below this, on the south side, was a series of dislocated benches like seat rows in an amphitheatre, but inclined at various angles to the horizontal; on the eastern side was the large mass of wall which had sunk perhaps a hundred feet as shown on the survey of Mr. Lydgate, and over this (of which the inner edge is much the higher) was the most comfortable, although not the most extensive, view of the molten pool, the heat at the usual point of observation being altogether unbearable.

This pool, to most visitors the great attraction of Kilauea, was, as we had supposed from the brilliant light reflected from the clouds the night before, in a remarkable state of activity. Not a sign of the alternate crusting over and breaking up so common a phenomenon on former visits to Halemaumau; all was in violent and excessive commotion within the banks of the great pool. At first the current controling the whole surface was strong towards the east bank, moving, as I estimated, at the rate of five miles an hour, but others visiting the pool on the same day at a later hour trebled this estimate. It seemed as if the molten contents were pouring out, and one looked at the opposite rim to note a subsidence, but there was none. Over the entire surface were jets by many score, not like the fountains seen when lava breaks from the mountain side or from the bottom of Mokuaweoweo, but jets more like those shown in Plate LX of Dana Lake. These were of varying diameter, but perhaps averaged twelve feet in height. All were moving in the current, but apparently independent of it in some degree, for frequently those behind would overtake the next in advance, melt into its substance and continue with accelerated speed: this action was repeated until perhaps ten were gathered into one great sheaf, increased in height as well as in diameter until the united mass was fifteen or more feet high and ten feet in diameter, when it dashed violently against the bank, throwing spatters on to the bench above and spinning abundance of Pele's hair from the drops. All the trail shown on Mr. Lydgate's map was covered by the splashes.[129]

These "traveling fountains," mentioned before by Mr. Baldwin, were new to me in all my observations of the Kilauean pools. Pele had not exhausted her repertoire, and presently some large, almost flat, floating islands appeared on the western margin. Whence they came was not evident, but they were very black, perhaps a hundred feet by fifty and appeared to be launched from the brilliant glow on the west coast. They had not floated a hundred yards from the shore before the jets (which I likened to dogs pursuing and jumping at their prey), seemed to bite mouthfuls from the sides until the mass seemed to writhe in pain, and near the midst of the pool a larger fountain, perhaps "Old Faithful," rose suddenly and swallowed what of the island the side skirmishers had left. Three other islands of similar size and form met the same fate before I started around the brink to discover the point of origin of these perishing islands, but on the journey round, the pool was not visible, and when, after some delays on the way to photograph the spatter-cones, the west bank was again in sight, the motion had reversed and the current was running as rapidly as before in the opposite direction, and no islands were on the surface. I looked for flames, but saw none. The vapors were at times very transparent, then of a bluish tinge, and again opaque and smoky. There was less noise than usual, for there were no falling crusts, only liquid lava. I was sorry not to see the reversal of current, but at former visits (when, however, the motion was by no means so rapid) the change was made with very little disturbance and little slackening of speed. The currents are a more common phenemenon but the speed is usually much less than at present; the apparently causeless change of direction is also familiar.

---

[129] This trail was marked in the copy of the map in the Register, but does not appear on the copy he sent me, which was used for the illustration.

The pool seemed somewhat larger than when measured by Mr. Lydgate, but still was not filling the bottom of the pit, and did not seem much higher. I tried to see what changes appeared in the surface of the boiling pool with the changes from clear to smoky fumes emitted, but the change was so gradual that no change was noted. On my way back to the Volcano House I passed a hot place on the trail about halfway between the pit and the bottom of the path down the bank, which I did not notice in the morning. From the first level stretch on the rising path there is a good view of the dome-like bottom of the crater. I had no means of measurement, but I do not feel deceived in thinking that this dome is at least fifty feet higher than it was last year. I have never seen the dome shape so distinct, and it seemed ready to overtop the western outer wall. When I first came to the spatter cones near the Rest House, I noticed a large cloud of steam issuing from near the base of Uwekahuna, but on my return two hours later it had disappeared; probably the effect of the rains during the previous night.

As the sunlight faded the beautiful peach blossom tint appeared on the vapor over the fire, and it deepened into red and orange as the night came on, until the wonderful effects of the previous night were surpassed.

INDEX TO VOLUME II.

While each Memoir is paged independently, the pagination of the volume will be found at the bottom of the page.

- Aa, 382, 394, 455, 474.
- Aha hawele, 147-151.
- Ahuawa, Cyperus lævigatus, 105, 106, 155.
  - preparation, 106.
- Akaakai, Scirpus lacustris, 84.
- Alapainui's platters for human shark bait, 175.
- Alexander, Mauna Loa in 1885, 536.
- Amerind basket, 1, 87.
- Analyses of lavas, 411.
- Analysis of stalactites, 410.
- Ancient walls of Kilauea, 427.
- Anderson, Kilauea in 1909, 596.
- Andrews, Mauna Loa in 1843, 441.
- Armor, Gilbert Islands, 19, 20.
- Attic in primitive houses, 230, 250.
- Auamo, see Bearing stick.
- Augite, 401, 407.
- Aumakua found in a cave, 165, 175.
- Australian basket, 26, 87-91, 103.
  - house, 255, 256.
- Autetaranga, Pimelea arenaria, 94.
- Awa bowls, 354.
  - strainers, 328.

- Baldwin, plan of Kilauea in 1908, 595.
- Balls covered with matting, 34.
- Baker, Mauna Loa in 1880-81, 526, 549.
  - Mauna Loa in 1885, 535.
- Bambu baskets, Pelew Islands, 26.
  - work, modern Hawaiian, 86.
- Banana fibre fabrics, 3, 4, 95-102.
  - leaves for sandals, 76.
  - see also Thatch.
- Baring-Gould, on human sacrifices, 212.
- Basalt, character of Hawaiian, 401.
  - prismatic, 402.
- Baskets, Amerind, 1, 87.
  - Australian, 26, 87-91, 103.
  - Caroline Islands, 6, 8, 9, 16, 20, 38.
  - Fijian, 26, 42, 47-49, 56, 57, 103.
  - Gilbert Islands, 6, 9, 10, 47-49, 103.
  - Hawaiian, 2, 34-37, 60-69, 102, 103.
  - Marshall Islands, 84.
  - New Britain, 26.
  - New Hebrides, 25, 103, 104.
  - New Zealand, 92-94, 103.
  - Pelew Islands, 26.
  - Philippine Islands, 5.
  - Samoan, 5, 6, 37-40, 102.
  - Santa Cruz, 26.
  - Solomon Islands, 7, 24-26, 103, 104.

- Baskets—*Continued.*
  - Tongan, 6, 21, 22.
  - bambu, 26.
  - coco-palm leaf, 5-10, 26.
  - coffin, 56, 57.
  - coir, 19, 20.
  - covered containers, 22, 63-66, 68.
  - fern-stem, 73.
  - fish, 24, 66-69, 73-75, 103.
  - grass, 84.
  - ieie (Freycinetia), 60-70.
  - palm-leaf, 16, 24-27.
  - Pandanus leaf, 34-39.
  - priority of invention of baskets or mats, 4.
  - rattan, 26, 87.
  - raw materials, 2-4.
  - Samoan superstitions, 39, 40.
  - summary, 102-105.
- Bath rubbers, 314.
- Bearing stick, 112, 317-320.
- Bird net, 154, 155.
- Bishop, S. E., Mauna Loa in 1868, 482.
  - plan of Kilauea, 562.
- Black sand, 405, 452.
- Blow-hole on Hualalai, 389.
- Bones, disposition after death of human, 177.
- Bow and arrow, Hawaiian, 375.
- Brigham:—
  - Mat and Basket Weaving of the Old Hawaiians, 1.
  - Old Hawaiian Carvings, 165.
  - The Ancient Hawaiian House, 185.
  - The Volcanoes of Kilauea and Mauna Loa, 379.
  - Hualalai in 1864, 387.
    - in 1889, 391.
  - Kilauea in 1864, 458.
    - in 1865, 466.
    - in 1880, 512.
  - Mauna Loa in 1864, 393.
    - in 1880, 397, 521.
- Brooms, 376.
- Broussonetia, see Waoke.
- Building a Fijian house, 207-210.
  - Hawaiian house, 261-293.
  - Samoan house, 200, 201.
  - Tongan house, 195.
- von Bülow, Samoan mat legend, 44.
- Byron, Kilauea in 1825, 422.

- Cabbage-palm satchels, 93.
- Canoe houses, 253, 254, 263, 264, 374.
- Carbonic acid, 407.

Caroline Islands, ball, 34.
  basket, 6, 8, 9, 16, 20, 38.
  fan, 12.
  hat, 30.
  house, 231-233.
  loom, 95, 100-102.
  mat, 32, 33, 95-102, 104.
  pillow, 33.
  sling, 22.
Carpenters, 195, 200, 208, 265, 268.
Carriage, Hawaiian, 317.
Carved dishes, 359.
Carving tool, 180, 181.
Carvings, Maori, see New Zealand house.
Cathedral cone, 453, 466.
Caves, dwelling, 259, 260.
  description of a burial cave, 165-167.
  in lava, 470, 475, 477.
  utilized for secreting relics, 167, 172, 174, 175.
Centrifugal motion in lava of Kilauea, 464.
Ceremonies connected with house building, 201, 211, 219, 241, 253, 266, 267, 276, 287, 288, 305.
Challenger Expedition, Kilauea in 1875, 507.
Chalmers, the New Guinea house, 238-241, 243.
Chase and Parker, Kilauea in 1838, 425.
Chlorine, 407.
Chronological history of the eruptions of Kilauea and Mauna Loa, 414.
Cinder cones of Mauna Kea, 383, 405.
Clinkstone, 402.
Coan, earthquake of 1868, 490.
  Kilauea in 1840, 428.
    in 1842, 435.
    in 1844, 1846, 436.
    in 1847, 1848, 439.
    in 1849-1854, 440.
    in 1855, 446.
    in 1856-1863, 452, 453.
    in 1868, 495.
    in 1869, 497.
  landslide of 1868, 492.
  Mauna Loa in 1843, 442.
    in 1849, 1851, 1852, 443.
    in 1855, 446.
    in 1856, 449.
    in 1868, 492.
    in 1875, 1877, 505.
    in 1880, 524.
    in 1881, 529.
  tidal wave of 1868, 491.
Coco-palm leaf baskets, 5-10, 26.
  leaf fans, 10-15.
  leaf for fences, screens, etc., 11.
  root fish trap, 24.
Coconut fibre, 2; see also Coir.
  utensils, 331-336.
Coir sennit, in basketry, 19-22.
  bound gourd, 22, 112, 147-151.
  braiding at public meetings, 21.
  encased in matting, 23, 52.
  for nettings, 128, 130, 155.
  preparation, 105, 106.

Coir sennit—*Continued.*
  windings, 20, 21, 270.
  see also House.
Coffin of basketry, 57, 56.
Comb of fern-stem, 73.
  Solomon Islands, 85.
Communal houses, 187, 218, 235, 244.
Cook, the Marquesan house, 191.
  the New Caledonian house, 250.
  the New Zealand house, 214-216.
  the Society Islands house, 191-193.
  the Tongan house, 194.
Cords, Hawaiian, 269.
Cordyline sp., see Ki and Cabbage-palm.
Crab net, 157.
Cross, Kilauea in 1902, 578.
Cyclopean structures, 185.
Cyperus lævigatus, see Makaloa and Ahuawa.

Dana, Kilauea in 1840, 433.
Dana Lake, 547, 562.
Date-palm hats, 24.
Deaths from eruptions, 392, 446.
  from land slide and tidal wave, 487, 496.
Decorated cord, 23, 52.
Dibble, eruption of 1789, 416.
Dilly baskets, 89-91.
Dodge, surveys of Kilauea, 547, 564, 567.
Dolerite, 401.
Dome in Kilauea, 438-440, 516, 600.
Door, shape and structure, 188, 190, 194, 198, 205, 206, 208, 209, 215, 216, 219, 220, 222, 223, 229-233, 239 250, 262, 264, 283, 284, 287, 289-291.
  Hawaiian, 283.
Douglas, Kilauea in 1834, 425.
  Mauna Loa in 1837, 441.
Dracæna, for sandals, 76.
Dresses, mat, from New Hebrides, 55, 56.
D'Urville, the New Guinea house, 237.
Dyes used in Samoan mats, 41.
  in Marshall Islands mats, 51.

Earthquakes of 1868, 479.
  of 1887, 543, 545.
Eel traps, 73.
Eke, 129, 146.
Electric action on lava, 411.
  currents in the lava, 471.
Elevation of Kilauea dome, 438-440, 515.
Ellis, the Hawaiian house, 263-266.
  Hualalai, 387, 390.
  Kilauea in 1823, 418, 419.
  preparation of gourds, 329.
Emerson, Kilauea in 1886, 540.
Erosion of lava-flows by the sea, 382.
Eskimo implements in Hawaii, 108, 109.
Etheridge, the Australian basket, 88.

Fans, 10-16, 24, 36, 42, 307.
  Hawaiian, 10-12, 24, 307.

Fans—*Continued.*
  coco-palm leaf, 10-15.
  found in a burial cave, 182.
  insignia of rank, 16.
  Pandanus, 12, 14.
Fau, see Hibiscus.
Feather cape, found in a cave, 182.
Fern-stem, use, 3, 4, 70-75.
  basket, 73.
  comb, 73.
  eel and fish traps and fish baskets, 73-75.
  hat, 72.
Ferrous oxide, 407.
Fibre mats, 94.
Fiji, basket or satchel, 26, 42, 47-49, 56, 103.
  coffin, 56, 57.
  fan, 14, 42.
  house, 203-214.
  mat, 41, 42.
  pillow, 206.
  temple, 23.
Finger bowls, 366-368.
Fire making, 298-301.
Fire-place, 197, 200, 205, 206, 208, 215, 216, 219, 233, 240, 250, 251, 262, 298, 329.
  Hawaiian, 298.
Fish baskets, 66-69, 73, 74.
  traps of fern-stem, 70, 73, 75, 103.
    of coco-palm roots, 24.
  nets, 152, 155-162.
    technique, 152, 156.
    material, 155.
Fison, Fijian sacrifices, 211, 212.
Flames in Kilauea, 464, 517.
Flax weaving of New Zealand, 92,'93; see Phormium.
Floating islands in lava, 556, 566, 567.
Flow of 1801, 386, 392.
  of 1823, 418, 478.
  of 1840, 429.
  of 1843, 442.
  of 1852, 443.
  of 1855, 446.
  of 1859, 453.
  of 1868, 479.
  of 1880-1881, 525.
  of 1887, 543.
  of 1899, 574.
  of 1907, 584.
Fly-flap, 15.
Forms of lava, 401-412.
Frear, Kilauea in 1894, 567.
Freycinet, Hawaiian baskets, 63, 64.
  Koko puupuu, 131.
Freycinetia sp., see Ieie.
Friedländer, Mauna Loa in 1896, 570.
Fumaroles, 405, 459, 547.
Funnels, gourd, 326, 327.
  wooden, found in cave, 182.
Furneaux' paintings, 397, 517, 526, 533, 545, 549.
Furniture of native houses, 188, 190, 192-194, 197, 200, 206, 219, 226, 228, 229, 234, 239, 243, 251, 253, 262, 266, 286, 305-378.
  of Hawaiian houses, 305-378.
Gases from volcanoes, 405, 517.
Gauges, mesh, 107, 110.
Gibson, Kilauea, 1895, 508.
Gilbert Islands, armor, 19, 20.
  ball, 34.
  basket or satchel, 6, 9, 10, 47-49, 103.
  house, 228-231.
  kite, 33.
  mat, 42, 43, 95-102, 104.
Gill nets, 162.
Gleichenia sp., 75, 85.
Goodrich, Kilauea in 1832, 524.
Gourd cordings, 22, 112, 147-151, 181.
  vessels and implements, 306, 321-331.
  water bottle found in cave, 181.
Gourds covered with basketry, 63, 68.
  decoration, 328-330.
  preparation, 306, 329.
Grass baskets, Marshall Islands, 84.
  work, Solomon Islands, 11, 75, 85, 86.
  see also Thatch.
Grasses, uses in mat making and basketry, 3, 4.
Green, on vapors from Kilauea, 406.
  Mauna Loa in 1859, 456.
    in 1873, 504.
    in 1875, 505.
Green Lake, 475.
Guam hat, 30.
  mat, 95-102.
Guppy, the Solomon Islands house, 250-254.
  the Solomon Islands mat, 42.

Hair, cutting, 307.
  method of attachment to statuettes, 170.
  in ornamentation, 11, 105, 130.
Haka, hakakau or oleole, 112, 266.
Hala, see Pandanus.
Halemaumau, 424, 427, 475.
Halema'uma'u, 475.
Hall, Mauna Loa in 1873, 500.
Hanai, 112, 121-126.
Hano ohua, 162.
Harakake, see Phormium.
Haskell, Mauna Loa, 453.
Hat, Hawaiian, 24, 72.
  Micronesian, 24, 30.
  fern-stem, 72.
  palm, 24.
  Pandanus, 30.
Hau, see Hibiscus.
Hawaiian Islands, ball, 34.
  bambu work, modern, 86.
  basket, 2, 5, 34-37, 60-69, 102, 103.
  cords, 269.
  fan, 10-12, 24.
  fish basket and trap, 66-70, 75, 103.
  furniture, 305-378.
  hat, 24, 72.
  house, 259-304.
  house building, 261-293.
  house, modern changes, 293-297.
  idol and helmet, 70, 71.

- Hawaiian Islands—*Continued.*
  - mat, 24, 27, 49, 52-55, 77-84, 104, 308, 309.
  - netting, 105-162.
  - pillow, 33, 34, 309.
  - sandals, 75-77.
  - sling, 23.
  - tapa, 310.
- Helmets of wicker work, 70, 71.
- Hervey Islands, fan, 13.
- Hibiscus fibre, Hau, Fau, Paritium tiliaceum, 2-4, 76, 94, 105, 106, 155, 271.
  - mats, 94, 98.
  - nets, 105, 106, 155.
  - preparation, 106.
  - sandals, 76.
  - see also House.
- Hillebrand, Kilauea in 1868, 484.
  - earthquake of 1868, 484-488.
  - flow of 1868, 489.
- Hinai poepoe, 64-66, 102, 149.
- Hinaki, 73, 74.
- History of eruptions, chronological, 414.
- Hitchcock, C. H., Prof., Mauna Loa and Kilauea in 1883, 534.
- Hitchcock, D. H., Mauna Loa in 1881, 527.
- Hitchcock, D. Howard, paintings, 451, 564, 570.
- Horse-hair for netted bags, 105, 130.
- House, Australian, 255, 256.
  - Caroline Islands, 231, 233.
  - Fijian, 203-214.
  - Gilbert Islands, 228-231.
  - Hawaiian, 259-304.
  - Marquesan, 188-191.
  - New Caledonian, 249, 250.
  - New Guinea, 234-244.
  - New Hebridean, 246-249.
  - New Zealand, 214-225.
  - Niue, 234.
  - Pelew Islands, 233, 234.
  - Samoan, 197-201.
  - Society Islands, 191-193.
  - Solomon Islands, 250-255.
  - Tongan, 194-197.
  - Trobriand Group, 245, 246.
  - Union Group, 225-228.
  - building terms, 301-304.
  - furniture, see Furniture.
  - ground plans, 187.
  - moving, 192, 199.
- Hualalai, ascent by Menzies, 386.
  - ascents by Ellis, Mann and Brigham, 387.
  - flow of 1801, 386, 392.
- Huewai, 147-151, 181; see also Gourds.
- Human hair in ornamentation, 11, 105, 130.
- Hudson, see Wilkes.
- Hydrochloric acid, 407.
- Hydrogen, 406.

- Idols of wicker work, 70, 71.
- Ieie, Freycinetia sp., 3, 4, 60, 61.
  - basket, 62, 63, 66-68.
  - covered vessels, 63-69.
- Ieie—*Continued.*
  - idols and helmets, 70, 71.
  - in Hawaiian house building, 263, 270.
  - preparation, 62.
- Ie sina, 94, 95.
- Individuality of primitive handicraft, 1.
- Ingalls, Mauna Loa in 1899, 574.
- Ipu aina, see Slop basins.
- Ipu holoi lima, see Finger bowls.
- Ipu holowaa, see Wooden dishes.
- Ipu kuha, see Spittoon.
- Ipu le'i, Ipu holoholona, Ipu aho, 148, 152, 373.
- Ipu mimi, 371.
- Ipu wai, see Gourd water bottle.
- Iwaiwa, see Fern-stems.

- Japanese basket, 73.
- Judd, escape at Kilauea in 1841, 435.

- Kaee, 159.
- Kaee paoo, 157.
- Kahili, used as a fly-flap, 15.
- Kahuku eruption of 1868, 489, 492.
- Kakai, 112, 126, 127.
- Kapa, see Tapa.
- Kapuni nehu, 160.
- Keanakakoi, 468, 469, 510.
- Keate, the Pelew Islands house, 233, 234.
- Kete, see New Zealand satchel.
- Ki leaf sandals, 76.
  - wrapper, 5, 6.
- Kilauea in 1789, 414.
  - in 1823, 418, 478.
  - in 1824, 420.
  - in 1825, 421.
  - in 1829, 424.
  - in 1832, 402, 424.
  - in 1834, 1838, 425.
  - in 1839, 427.
  - in 1840, 428.
  - in 1841, 434.
  - in 1842, 435.
  - in 1844, 1846, 436.
  - in 1847, 1848, 439.
  - in 1849-1854, 440.
  - in 1855, 446.
  - in 1856-1863, 452, 453.
  - in 1864, 458.
  - in 1865, 466.
  - in 1868, 478, 484, 491, 495.
  - in 1869-1872, 497.
  - in 1873, 497-501.
  - in 1874, 501-503.
  - in 1875, 506.
  - in 1876-1877, 508.
  - in 1878-1879, 510.
  - in 1880, 511, 524.
  - in 1881, 533.
  - in 1882-1884, 534.
  - in 1885, 535.
  - in 1886, 540.

- Kilauea in 1887, 546.
  - in 1888, 546, 549.
  - in 1889, 552.
  - in 1890, 552, 553.
  - in 1891, 553.
  - in 1892, 562.
  - in 1893, 1894, 563.
  - in 1895, 570.
  - in 1896, 570, 574.
  - in 1897, 574.
  - in 1898, 1900, 577.
  - in 1901, 1902, 578.
  - in 1903, 580, 582.
  - in 1904, 1905, 582.
  - in 1906, 584.
  - in 1907, 587.
  - in 1908, 587, 595.
  - in 1909, 595.
- Kilauea iki, 420, 424, 567, 467, 486, 508.
- Kilou, wooden hook, 112, 376.
- Kinnear's sketch of Halemaumau, 511.
- Kinney and Fuller, flow of 1852, 445.
- Kioe, net mender, 107, 111.
- Kites, Gilbert Islands, 33.
- Knitted bags, 105, 130-132.
- Koko, 112-147, 306.
  - ipu le'i, 149.
  - makalii, and Koko maoloha, 137-140.
  - pualu, 128, 129, 141.
  - puupuu, 128-137, 143.
- Konane, 178-180, 378.
- Krämer, Marshall Islands mats, 50, 51.
- Kusaie, see Caroline Islands.

- Laau lomilomi, 313, 314.
- Lafoga game, 47.
- Lamps and lighting, 200, 314, 315.
- Lanai of Hawaiian house, 289.
- Landslide of 1868, 480, 487, 492.
- Lava, analyses, 411.
  - character and forms of Hawaiian, 401-412.
  - fountains of Mauna Loa, 455.
  - spring, 519.
- Limonite, 407.
- Limu, Hawaiian pumice, 382, 457, 470, 522.
- Little Beggar, 535.
- Little Elephant cone, 549.
- Lomilomi or massage, 313, 314.
- Loom, Micronesia, 95-102.
  - New Zealand, 2, 92.
  - Ontong Java, 95-97.
  - Santa Cruz, 96.
  - absence in Polynesia proper, 2.
  - -woven mats, 95-102.
- Loomis, Kilauea in 1824, 420.
- Loulu-palm, Pritchardia sp., 24.
  - mats, 27.
- Lua Pele, 439.
- Lydgate, plans of Kilauea, 497, 507, 596.
  - plan of Mokuaweoweo, 501, 523.
- Lyman, C. S., Kilauea in 1846, 436, 439.
- Lyman, F. S., earthquakes of 1868, 479.
- Magnetite, 401.
- Makaloa, Cyperus laevigatus, 3.
  - mats, 77-83.
    - ornamentation, 78-80.
    - preparation and technique, 77, 78.
- Makaopuhi crater, 432, 475.
- Malo, David, the Hawaiian house, 260-263.
  - house furniture, 306, 307.
  - Koko a Maoloha, 138, 139.
- Mamake, Pipturus albidus, 3.
- Mann and Brigham, see Brigham.
- Maoloha, 137-140.
- Mariapu, 229.
- Mariner, the Tongan house, 195, 196.
  - Tongan mats and baskets, 21.
- Marquesan house, 188-191.
  - sling, 22.
- Marshall Islands basket, 84.
  - fan, 12, 14, 15.
  - mat, 31, 43, 49-52, 59.
  - sails, 46, 47.
- Massage, 313, 314.
- Mats, Caroline Islands, 32, 33, 95-102.
  - Fijian, 41, 42.
  - Gilbert Islands, 42, 43, 95-102.
  - Guam, 95-102.
  - Hawaiian, 24, 27, 49, 52-55, 58, 59, 77-84, 104, 308.
  - Marshall Islands, 31, 43, 49-52, 59.
    - technique and implements, 50-52.
    - dyes, 51.
  - New Guinea, 104.
  - New Hebrides, 55, 56, 104.
  - New Zealand, 104.
  - Niue, 100.
  - Samoan, 40, 41, 43-45, 47, 94, 95, 104.
    - preparation and technique, 40, 41.
  - Santa Cruz, 100.
  - Solomon Islands, 32, 42, 104.
  - Tongan, 21, 22, 104.
  - akaakai, 84.
  - banana fibre, 98, 100-102.
  - coverings for sails, 33.
  - for clothing, 49-52, 55, 56, 80.
  - Hibiscus fibre, 94, 98.
  - legends, 43-45.
  - loom-woven, 95-102.
  - makaloa, 77-83; see also Makaloa.
  - palm-leaf, 27.
  - Pandanus, 31-33, 40-47, 49-56, 58, 59.
  - priority of invention of baskets or mats, 4, 5.
  - raw materials, 2-4.
  - sails, 46, 47.
  - summary, 104, 105.
  - whole leaf, 31-33.
  - see also Furniture.
- Mauna Hualalai, see Hualalai.
- Mauna Kea, 383.
- Mauna Kohala, 383.
- Mauna Loa, area, 539.
  - ascent by Douglas in 1834, 425.
  - in 1832-1837, 441.
  - in 1841, 395, 441.
  - in 1843, 441.

Mauna Loa in 1849, 1851, 1852, 443.
  in 1855, 446.
  in 1856, 449.
  in 1859, 453.
  in 1864, 393.
  in 1868, 479.
  in 1868-1872, 503.
  in 1873, 498, 500, 501, 504.
  in 1874, 501, 502.
  in 1875-1877, 505.
  in 1879, 510.
  in 1880, 397, 511, 521.
  in 1880, 1881, 525.
  in 1885, 535, 536.
  in 1887, 543.
  in 1888, 546.
  in 1890, 552.
  in 1892, 563.
  in 1896, 570.
  in 1899, 574.
  in 1903, 580.
  in 1905, 582.
  in 1907, 584.
Mbure, 205.
Medicine bowl, 356.
Menzies, ascent of Hualalai, 386.
Merritt, Mauna Loa, 1888, 546.
Mesh, sizes, 107.
Mica, 401, 407.
Minerals from Hawaiian volcanoes, 407.
Mirrors, 307, 371, 372.
Model of Kilauea, 579.
Mortar and pestle, 315.
Mu or konane; 178-180, 378.
Mud-flow of 1868; see Landslide.
Musa, see Banana.

Nae, 152-154.
  netting for feather garments, 152, 153.
Net menders, kioe, 107, 111.
Nets, fish, 152, 155-162.
  floats and sinkers, 156.
  joining, 108, 156.
Netted bag, Hawaiian, 112-147.
  malo, 154.
Netting, Hawaiian, 105-162.
  New Guinea, 104.
  classification, 111.
  tools, 107.
New Britain, basket, 26.
New Caledonian house, 249, 250.
  gourd, 22.
New Guinea house, 234-244.
  mat, 104.
  netted bags, 104.
  pillow, 243.
New Hebrides, basket, 25, 103, 104.
  house, 246-249.
  mat, 55, 56, 104.
New Zealand fish traps, 73-75, 103.
  flax, see Phormium.
  house, 214-225.
New Zealand mat, 104.
  satchel or basket, 92-94, 103.
Niue house, 234.
Niihau mats, see Makaloa.

Observatory at Kilauea, 596.
Old Faithful, 567.
Oleole or haka, 112, 266.
Olivine, 401, 407, 432, 462.
Olona, Touchardia latifolia, 3, 4, 105, 106, 130, 155, 270, 271.
Olowai, 147, 148, 151.
Ontong Java loom, 95-97.
Ornamentation in Fijian houses, 208.
  New Zealand houses; see New Zealand house.
  Tongan houses, 197.
Oven, 329.

Pahoehoe, 380, 402.
Palm-leaf baskets, 16, 24.
  mats 27.
Palms, uses, 4.
Pandanus, hala, lauhala, 2, 4, 28-59, 76, 104.
  baskets, 34-39.
  fans, 12, 14.
  hats, 30.
  kites, 33.
  mat sails, 46, 47.
  mats, 40-45, 49-56, 58, 59.
    sail covers, 33.
    whole leaf, 31-33.
  preparation, 30, 40, 42, 43, 51, 53.
  sandals, 76.
  satchels, 47.
  see also Thatch.
Papa kupalupalu mano, 175.
Papamu or konane board, 179, 180, 378.
Paper mulberry, see Waoke.
Paritium tiliaceum, see Hibiscus.
Parkinson, Ontong Java loom, 97, 98.
Pataka, 220.
Pele's hair, 395, 401, 411, 463, 515.
  analyses, 411.
Pelew Islands, basket, 26.
  house, 233, 234.
du Petit-Thouars, the Hawaiian house, 295.
Philippine Islands, basket, 5.
Phonolite, 402.
Phormium tenax, 2, 92.
  weaving, 92.
Pickering, Kilauea in 1841, 434.
Piko, 112, 114-121.
Pile dwellings, New Guinea, 236-244.
  Solomon Islands, 252.
Pili grass, 271.
Pillows, 33, 34, 190, 193, 200, 206, 219, 243, 253, 266, 309.
  Caroline Islands, 33.
  Fijian, 206.
  Hawaiian, 33, 266, 309.
  New Guinea, 243.
  Samoan, 200.

- Pillows, Tongan, 194.
  - covered with matting, 33, 34, 309.
- Pipturus albidus, see Mamaki.
- Pit craters of Hualalai, 388.
  - in Puna, 472.
- Pohaku Hanalei crater, 521, 582.
- Poho aho, 148, 152.
- Poi pounding, 316.
- Poli o Keawe crater, 471.
- Ponahohoa, 418, 518.
- Ponape, see Caroline Islands.
- Pope, Mauna Loa in 1905, 582.
- Porcelain fragment found in cave, 182.
- Prismatic basalt, 402.
- Pritchardia sp., 24.
- Pukanahi crater, 526.
- Pulu, 471.
- Pumice, 401; see also Limu.
- Puna, legendary lava flows, 477.
  - pit craters, 472.

- Quartz, 407.

- Radium, 558.
- Rate of landslide, 480, 492.
- Rate of lava flows, 392, 429, 445, 447, 448, 450, 451, 453, 454, 483, 494, 527, 529, 531, 545, 584, 585.
- Rattan baskets, 26, 87.
  - shields, 16-19.
  - sleeping mats, 27.
- Relics hidden in caves, 167, 172, 174, 175.
- Ridgeway's plan of Mokuaweoweo, 580.
- River beds changed, 382.
- Rope-lava, 401, 402.

- Sacred houses or temples, 202, 203, 205, 227, 238, 243, 244, 250, 253, 254.
- Sacrifices in house building, 211, 219, 253, 254, 276.
- Sail covers of mat, 33.
- Sails from matting, 46, 47.
- Salt making, 306.
- Salts in lava, 392, 407, 432, 447, 495.
- Samoan basket, 5, 6, 37-40, 102.
  - fan, 12-14.
  - fish trap, 24, 103.
  - house, 197-201.
  - mat, 40, 41, 43-45, 47, 94, 95, 104.
  - pillow, 200.
  - temple, 202, 203.
- Sandals, Hawaiian, 75-77.
- Santa Cruz, basket, 26.
  - loom, 96.
- Satchels, Fijian, 47-49.
  - Gilbert Islands, 47-49.
  - New Zealand, 92-94, 103.
  - of Pandanus, 47.
- Schaefer, Kilauea in 1874, 502.
- Scirpus lacustris, 84.
- Scoria, 405.
- Scott's sketch of Kilauea, 507.
- Scrapers, 373.
- Sculpture, Maori, see New Zealand house.
- Seemann, Fijian mat, 41, 42.
- Seines, 162.
- Sennit, see Coir.
- Severance, plan of Mokuaweoweo, 523.
- Shark net, 108, 155, 162.
- Shepherd, Kilauea in 1839, 427.
- Shields, Solomon Islands, 16-19.
- Shrimp trap, 70.
- Shuttle for netting, 107, 110.
- Slings, 22, 23.
- Slop basins, Ipu aina, 176-178, 368, 369.
- Smyth, Australian basket, 88.
- Snow on Mauna Kea, 383.
  - on Mauna Loa, 396, 454.
- Society Islands, fan, 13, 36.
  - house, 191-193.
- Solomon Islands, basket, 7, 24-26, 103, 104.
  - fan, 10.
  - grass work, 11, 85, 86.
  - house, 250-255.
  - mat, 32, 42, 104.
  - shield 16-19.
- Spittoons, 177, 369, 370.
- Stair, Samoan temples, 202.
- Stalactites and stalagmites, 407, 471.
- Statuettes, Hawaiian, 168-171.
- Steam, volcanic, 405, 406, 505.
- Stein, Samoan mat, 40, 41.
- Steubel, Samoan mat legend, 44.
- Stewart, the Hawaiian house, 285-287.
  - the Marquesan house, 188-190.
  - Kilauea in 1825, 421.
  - Kilauea in 1829, 424.
- Stokes, Hawaiian Nets and Netting, 105.
- Stone structures, 185, 186, 203, 233.
- Stony lavas, 402.
- Stools, 192-194, 226, 228, 376.
- Store house, New Zealand, 220.
- Strainers, awa, 328.
- Strzelecki, Kilauea in 1838, 426.
- Sugar cane for braids in hat making, 86.
  - see also Thatch.
- Sulphide of iron, 407.
- Sulphur beds, 432, 460, 469, 518.
- Sulphurous acid gas, 407.
- Superstition connected with Samoan basket, 39, 40.

- Tahiti, see Society Islands.
- Tanning of fish nets, 156.
- Tapa or kapa, 2, 310-312.
  - implements, 311.
  - wrappings, 167.
  - see also Furniture.
- Taylor, the New Zealand house, 218-220.
- Teeth, artificial, inserted in statuette, 169, 170.
  - disposition of human, after death, 177.
- Temple, Samoan, 202, 203.
  - Fijian, covered with sennit, 23.
  - see also Sacred houses.

Thatch, 188, 189-192, 195, 197, 199, 204, 205, 208, 209, 214, 216, 220, 226, 229, 230, 234, 240, 244, 248, 250, 252-254, 256, 260, 262-264, 271, 279-283, 286.
Thatching, Hawaiian house, 271, 279-283.
Thurston, Kilauea in 1894, 565.
  Mauna Loa in 1890, 552.
Thurston Lake, 563.
Tidal wave of 1872, 503.
  of 1868, 481, 491.
Timber for Hawaiian houses, 267.
Tokens of virginity, 95.
Tol, 100-102.
Toler, Kilauea in 1877, 508.
Tongan basket, 6, 21, 22.
  house, 194-197.
  mat, 21, 22, 104.
Tools for Hawaiian house building, 268, 269.
Torches, 314.
Tortoise shell vessels, 234, 356.
Touchardia latifolia, see Olona.
Traveling fountains, 595, 599.
Tree houses of New Guinea, 244.
  moulds of lava, 394, 430, 474, 489, 580.
Trobriand Islands house, 245, 246.
Tufa, 402.
Turner, the Samoan house, 198-201.
  Samoan mats and baskets, 38-40.
Turtle nets, 108, 155, 162.

Ukiuki grass, 3, 270.
Uluna, see Pillows.
Umeke laau, see Wooden bowls.
Union Group, house, 225-228.
Upena, see Fish nets.
Upena manu, bird net, 154.

Van Slyke, Kilauea, 1886, 542.
Vapors from volcanoes, 405.
Vegetation on Hualalai, 388, 390.
  on Mauna Loa, 397.
Volcanic sand, 405.

Waldron's Ledge, 461.
Waoke, paper mulberry, Broussonetia papyrifera, 2-4, 76, 105, 106, 271.
  cord, 105, 106, 130.
  cultivated, 4.
  sandals, 76.
  see also Tapa.
Warm house or whare puni, 218-220.
  springs, 392, 476.
Water gourds, corded, 147-151; see also Gourds.
Watering ships, 374.
West, the Tongan house, 196, 197.
Whakarapa, 73, 74.
Whitney, Mauna Loa in 1868, 483.
Wilkes, the Fijian house, 204-206.
  the Gilbert Islands house, 229, 230.
  the Gilbert Islands mat, 42, 43.
  the Union Group house, 226-228.
Wilkes, Kilauea in 1841, 434.
  Mauna Loa in 1841, 395, 441.
Williams, the Fijian house, 207-210.
Wilson, the Marquesan house, 188.
Winding cord, 20, 21, 270.
Wooden vessels covered with basketry, 22, 63.
  bowls, 306, 336-353, 362-366.
    carved, 359.
    making, 306, 343-349.
  dishes, 353-360.
  vessels, 336-371.
Woods for Hawaiian bowls, 340-342.
  for Hawaiian house building, 267.

PUBLICATIONS OF THE BERNICE PAUAHI BISHOP MUSEUM

(All previous price lists are hereby cancelled.)

A Handbook for the Bishop Museum. Oblong octavo, 94 half-tone illustrations. Price 25 cts., postage 9 cts.

Index to Abraham Fornander's "Polynesian Race." By John F. G. Stokes. Price $1.75, postage 5 cts.

Occasional Papers, Vol. I. Octavo.

No. 1. Director's Report, 1898. Visits to Ethnological museums in a journey around the world. [Out of print.]

No. 2. Director's Annual Report, 1899. Mat Sails of the Pacific—Stokes. Ray-skin Rasps—Walcott. Notes on the Birds of Oahu—Seale. Price 50 cts., postage 4 cts.

No. 3. Director's Annual Report, 1900. Visit to the American museums—Stokes. Mission to Guam—Seale. Notes on the Birds of Kauai—Bryan and Seale. Price $1.00, postage 8 cts.

No. 4. New Hawaiian Fishes—Seale. Price 25 cents; postage 2 cts.

No. 5. Director's Annual Report, 1901, and Index to Vol. I. Illustrations of sperm whale and bird groups. Price 50 cts., postage 4 cts.

Occasional Papers, Vol. II.

No. 1. Director's Annual Report, 1902. Noteworthy Hawaiian Stone Implements—Brigham. Fibres of the Hawaiian Islands—Blackman. Distribution and Variation of Achatinella multizonata—Cooke. Monograph of Marcus Island—Bryan. Price $1.00, postage 7 cts.

No. 2. Director's Annual Report, 1903. Remarks on Phallic Stones from Rapanui—J. L. Young. Aboriginal Wooden Weapons of Australia—Blackman. Price 40 cts., postage 4 cts.

No. 3. Director's Annual Report, 1904. Australian Bark Canoe—Brigham. A Stone Dagger for Duelling—Brigham. Notes on the Birds of the Waianae Mountains—Bryan. Additional Notes on the Nesting Habits of the Hawaiian Owl—Bryan. Description of the Nest and Eggs of Chlorodrepanis virens (Gmel.)—Bryan. Notes on the American Birds Collected in the Hawaiian Islands by Mr. Gerrit Wilder—Bryan. A Bird's Nest of Pele's Hair—Bryan. Two Undescribed Nests and an Egg of a Hawaiian Bird—Bryan. Price 50 cts., postage 5 cts.

No. 4. Director's Annual Report, 1905. Three New Hawaiian Fishes—Bryan. Report of a Visit to Midway Island—Bryan. Nest of Hawaiian Hawk—Bryan. Price 50 cts., postage 4 cts.

No. 5. Director's Annual Report, 1906, and Index to Vol. II. Dr. Cooke's Report on Types of Hawaiian Land Shells. Price 20 cts., postage 2 cts.

Occasional Papers, Vol. III.

No. 1. Reprint of Original Descriptions of Achatinella. By E. W. Thwing. Price $1.50, postage 9 cts.

No. 2. Notes on Hawaiian Land Shells—Pilsbry and Cooke. Price 25 cts., postage 2 cts.

(OVER)

PUBLICATIONS—Continued.

Occasional Papers, Vol. IV.

No. 1. Fishes of the South Pacific—Seale. Price $1.00, postage 5 cts.

No. 2. Director's Annual Report, 1907. Casts of Hawaiian Fishes, made by John W. Thompson. Stone Sculpturings in Relief—Stokes. Some Birds of Molokai—Bryan. Price 75 cts., postage 5 cts.

No. 3. Director's Annual Report, 1908. Walled Fish Traps of Pearl Harbor—Stokes. Some New Hawaiian Plants—Forbes. Price 40 cts., postage 3 cts.

Memoirs, Vol. I. Quarto.

No. 1. Hawaiian Feather Work. By Wm. T. Brigham. Price $2.50, postage 14 cts.

No. 2. Index to the Islands of the Pacific. By Wm. T. Brigham. Price $1.50, postage 20 cts.

No. 3. Key to the Birds of the Hawaiian Group. By Wm. Alanson Bryan. Price $1.50, postage 13 cts.

No. 4. Ancient Hawaiian Stone Implements. By Wm. T. Brigham. Price $2.50, postage 20 cts.

No. 5. Supplement to Hawaiian Feather Work, with Index to Vol. I. By Wm. T. Brigham. Price 75 cts., postage 8 cts.

Memoirs, Vol. II.

No. 1. Hawaiian Mat and Basket Weaving. By Wm. T. Brigham. —Hawaiian Nets and Nettings. By J. F. G. Stokes. Price $3.00, postage 20 cts.

No. 2. Old Hawaiian Carvings—By Wm. T. Brigham. Price 50 cts., postage 5 cts.

No. 3. The Ancient Hawaiian House. By Wm. T. Brigham. Price $3.00, postage 25 cts.

No. 4. The Volcanoes of Kilauea and Mauna Loa. By Wm. T. Brigham. Price $3.50, postage 30 cts. Completing the volume.

Vol. III. Kapa Making. In preparation.

PLATES.

PLATE I.

Micronesian Baskets.

5631 Rude basket or frail of coconut leaves. Caroline Ids.
7559 Basket of palm leaf. Ponape.
3346 Coiled basket of palm. Caroline Ids.
7800 Small palm leaf basket. Caroline Ids.
8081 Knotted basket of pandanus. Nawodo, Caroline Ids.
4024 Knotted basket of pandanus. Caroline Ids.
7578 Covered basket of coconut leaves.
3347 Decorated basket of grass. Maloelab, Marshall Ids.
7796 Basket of sennit. Ponape.

Plate I.

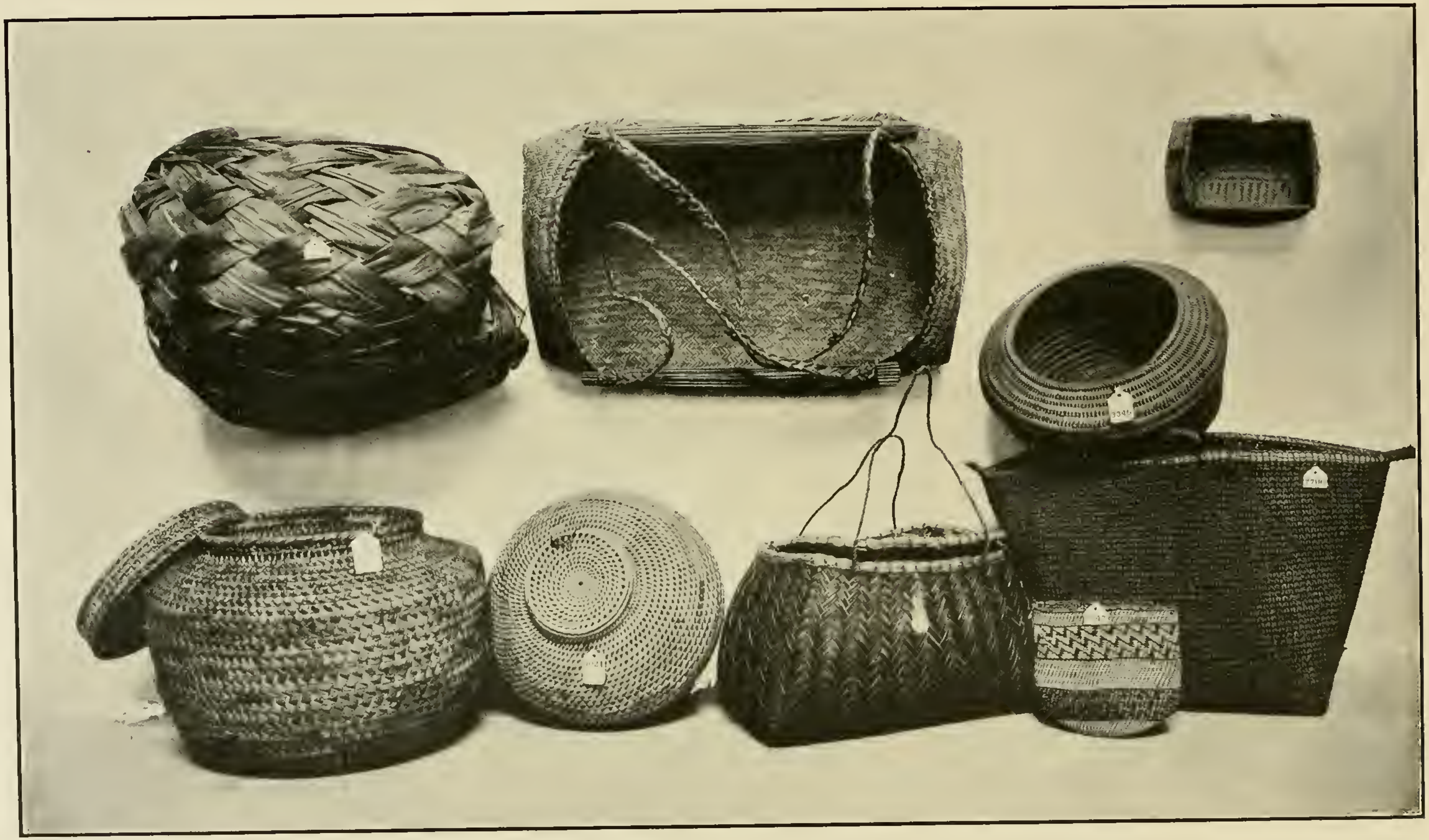


PLATE II.

MICRONESIAN BASKETS.

7096	Satchel of pandanus from Gilbert Ids.
7095	Folio of pandanus made like the preceding, from the same group.
3497	Sack of pandanus, continuous weave at sides, interwoven at bottom.
7094	Satchel of pandanus.
3351	Basket of pandanus embroidered with human hair.
3349	Satchel of pandanus coarsely woven.
3350	Basket of pandanus, double throughout; common Gilbert Ids. form.
3353	Basket of pandanus sewed with human hair cord; Tapiteuea.
6399	Basket from Tapiteuea, Gilbert group.
7518	Basket of coco leaf.
6398	Basket of pandanus from Tokelau, Gilbert group.
3352	Basket from Tapiteuea; sewed with human hair cord.

PLATE II.

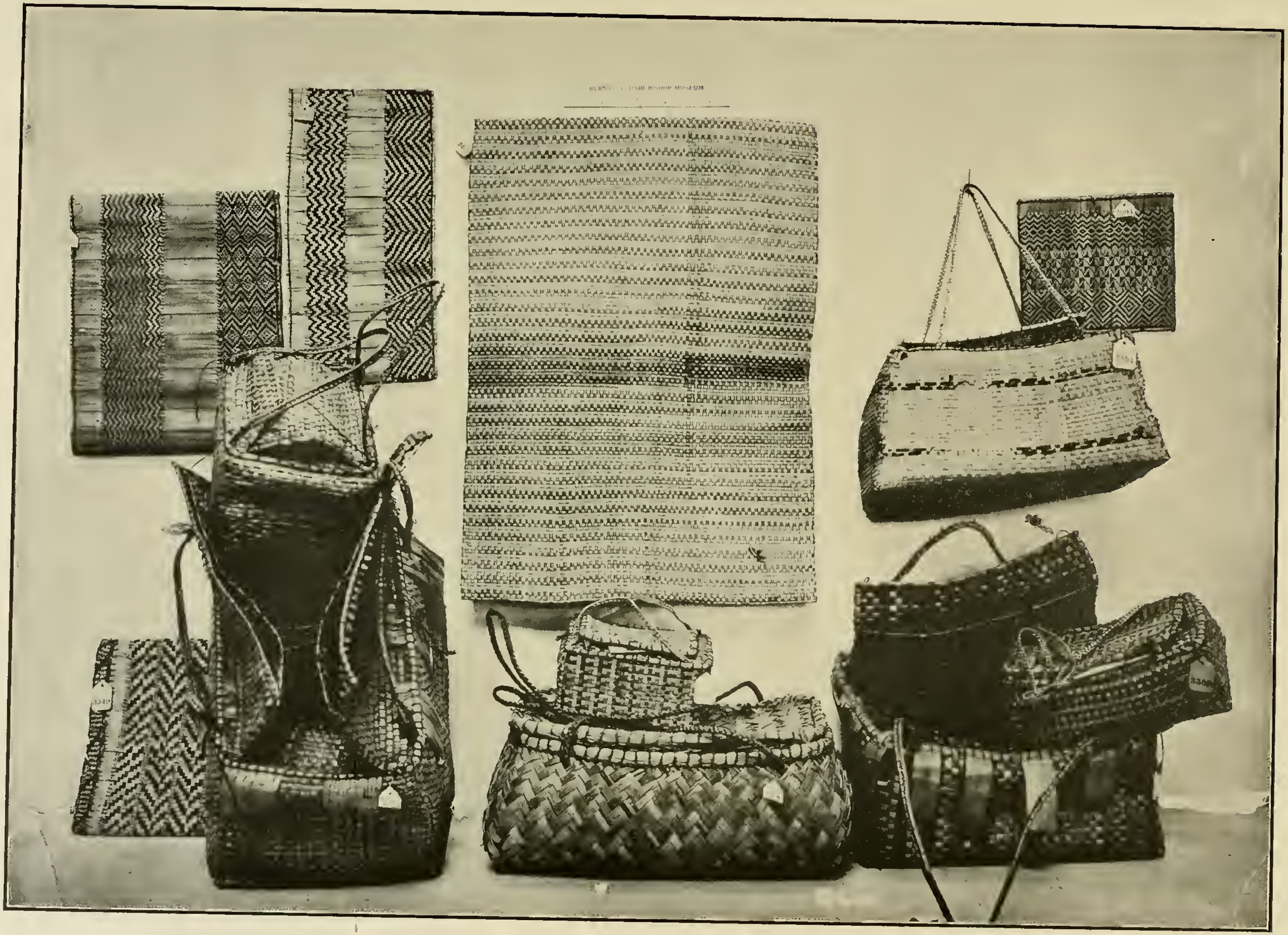


PLATE III.

Hawaiian Sandals = Na Kamaa maoli.

4547 Sandals, ki leaves (*Cordyline terminalis*): well braided.

5107 Sandals of poaaha or partly beaten waoke (*Broussonetia papyrifera*).

4538 Sandals of waoke similar to the last.

4535 Sandals of pandanus leaves; Na Kamaa lauhala.

4540 Sandals of banana leaf; Na Kamaa maia.

4546 Sandals of ki leaves; Na Kamaa lai ki.

4548 Sandals of ki leaves; Na Kamaa lai ki.

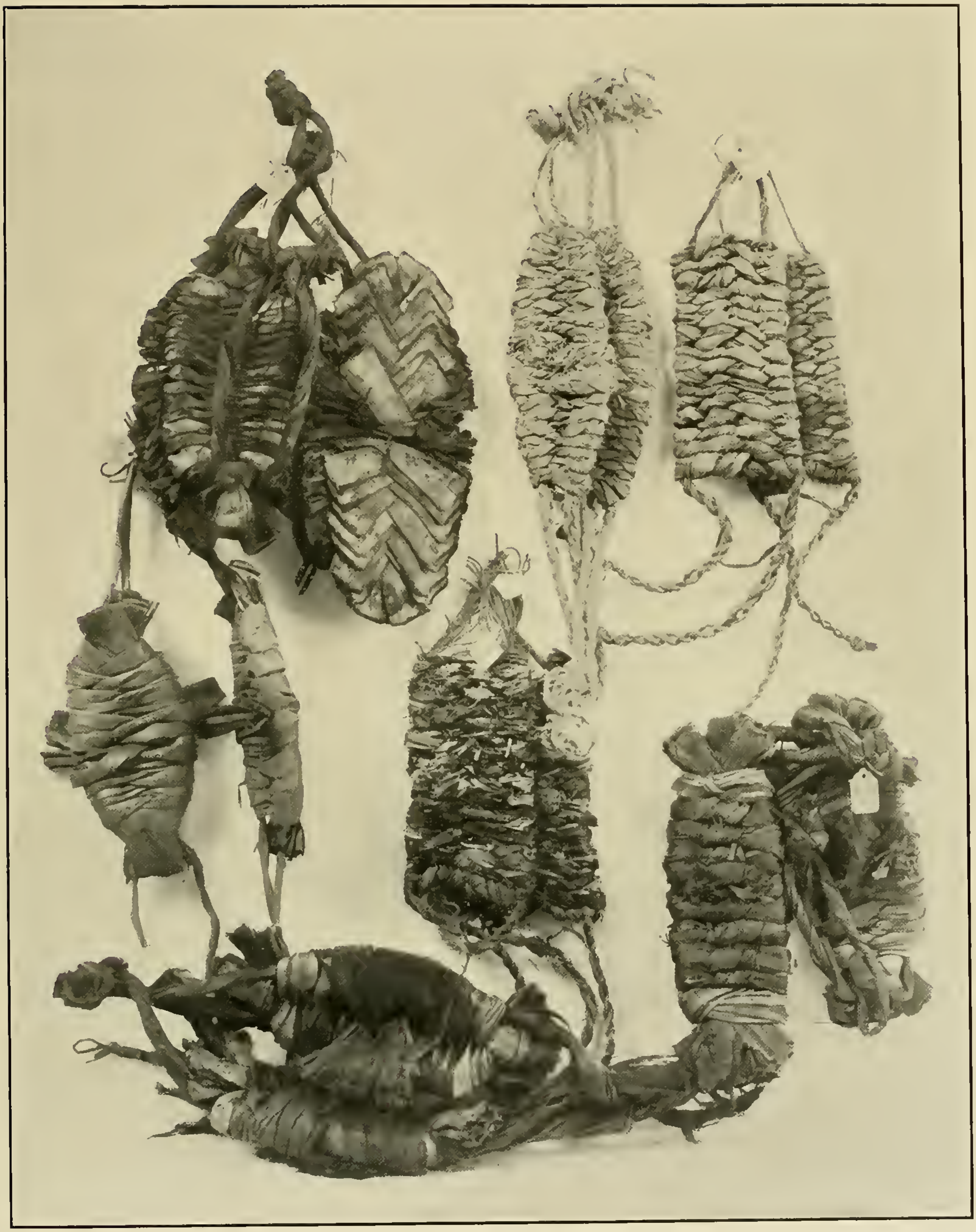


PLATE IV.

Hawaiian Fish Baskets or Traps.

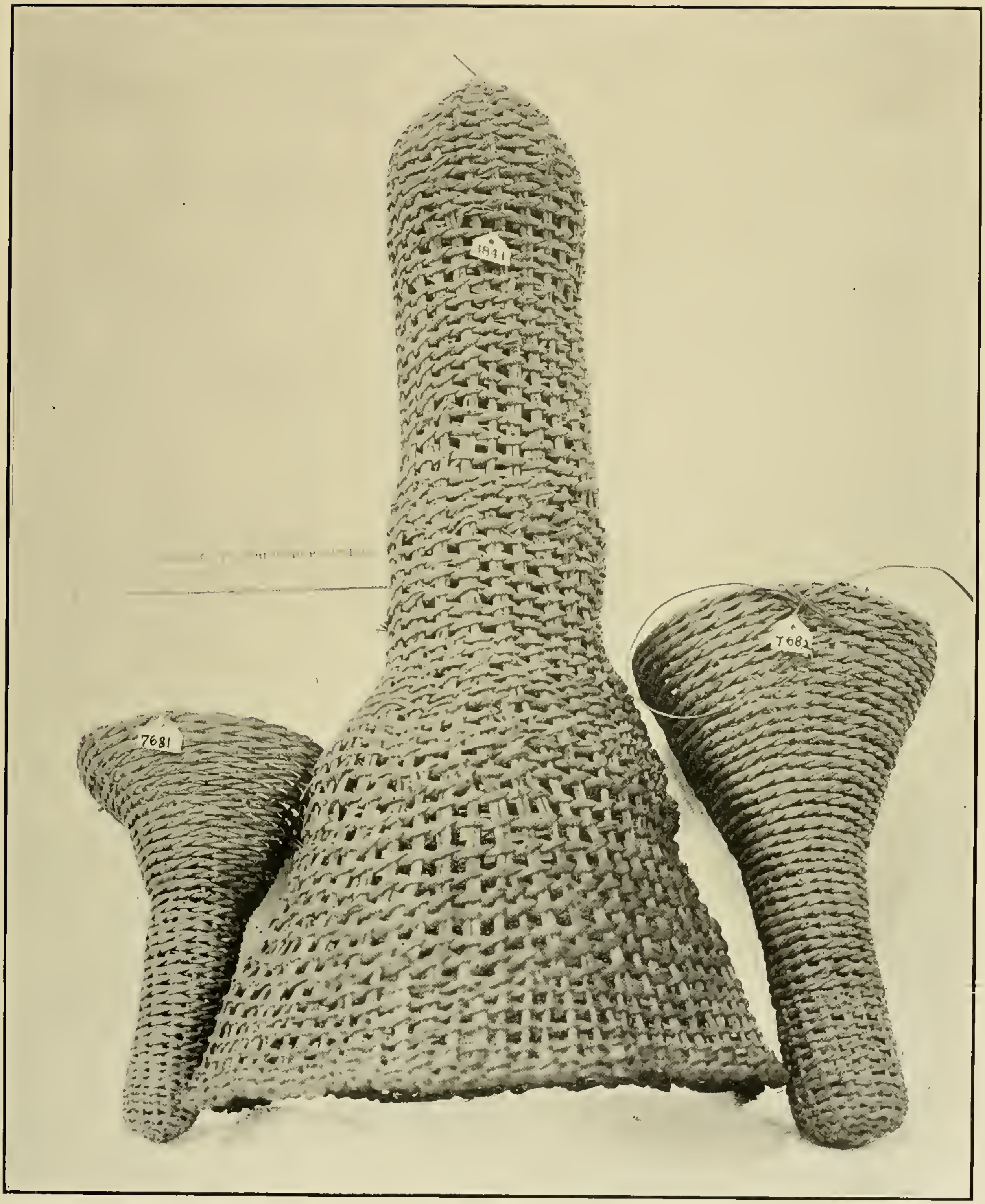

1841
7681
7682

PLATE V.

Corner of a pandanus leaf mat of large size used by the author as a table cover. The full size is 6 ft. 10 in. by 6 ft. 7 in. The border is about 13 in. wide.

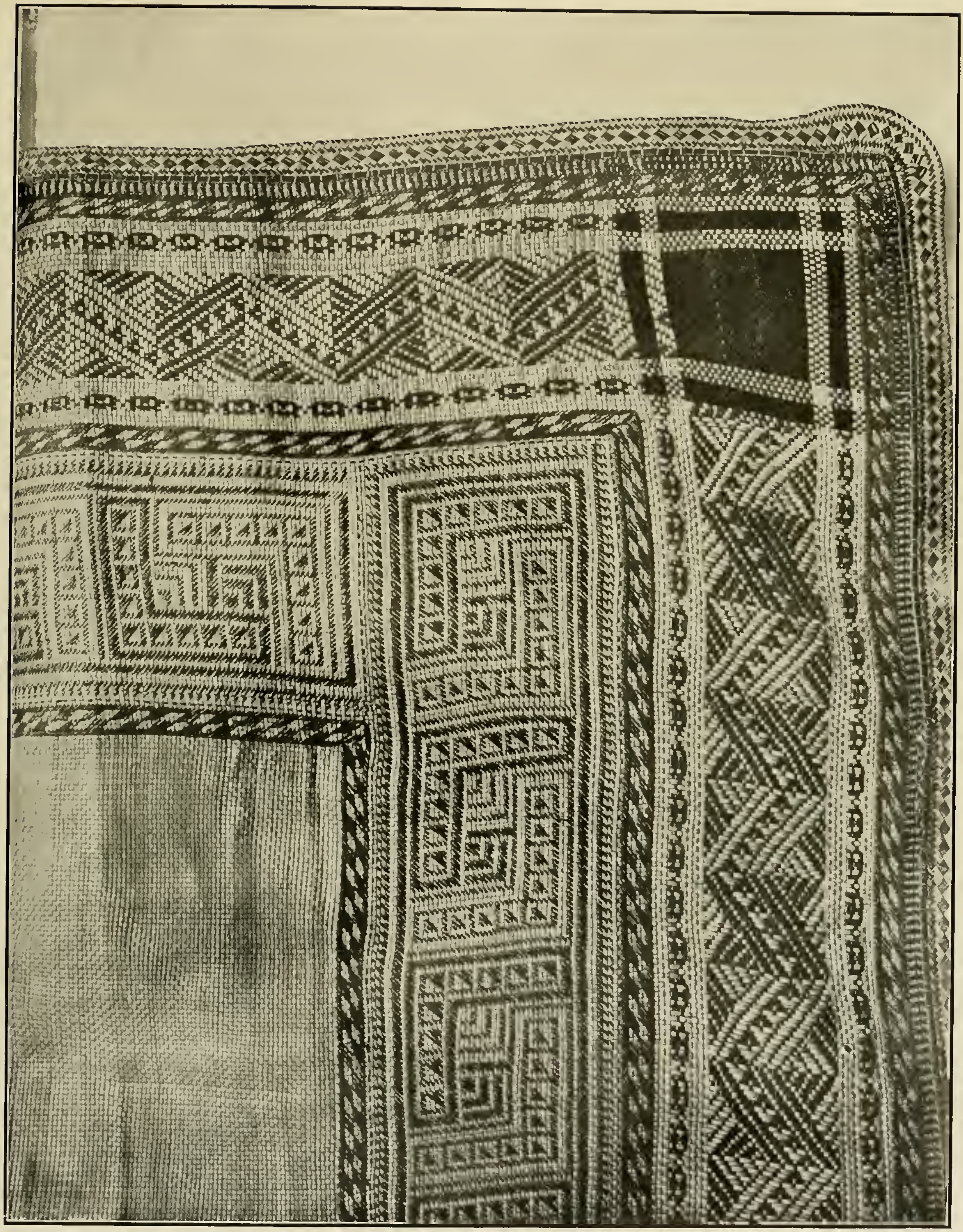
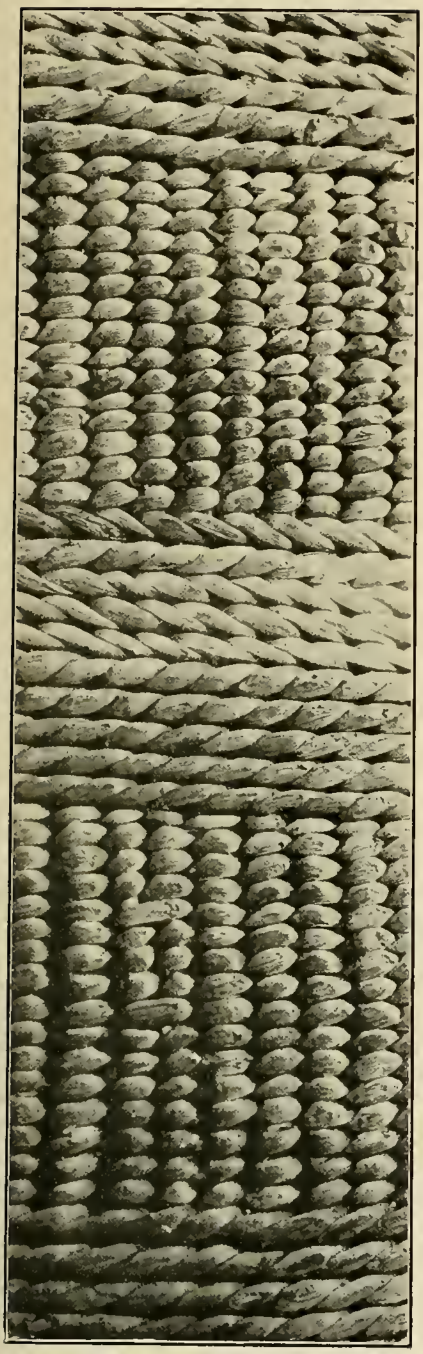
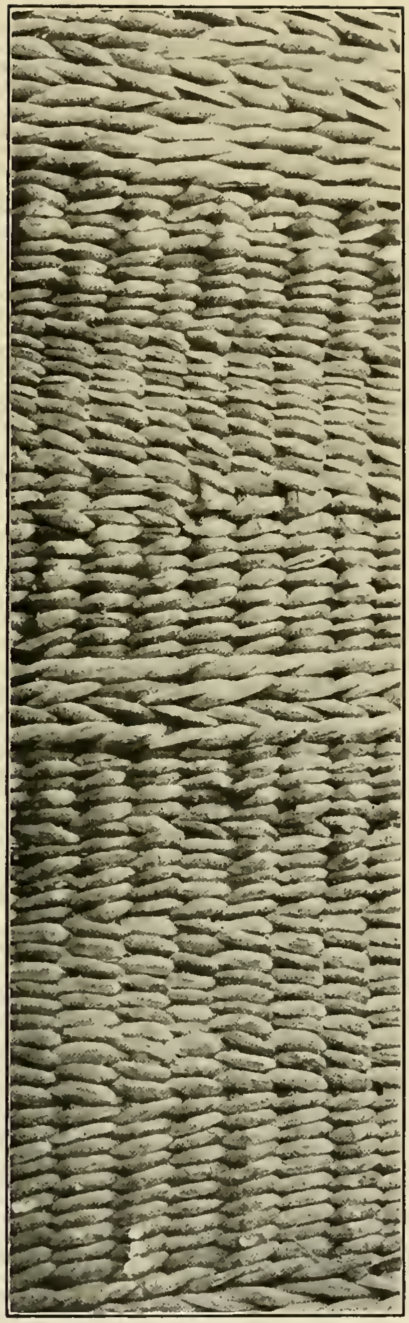


PLATE VI.

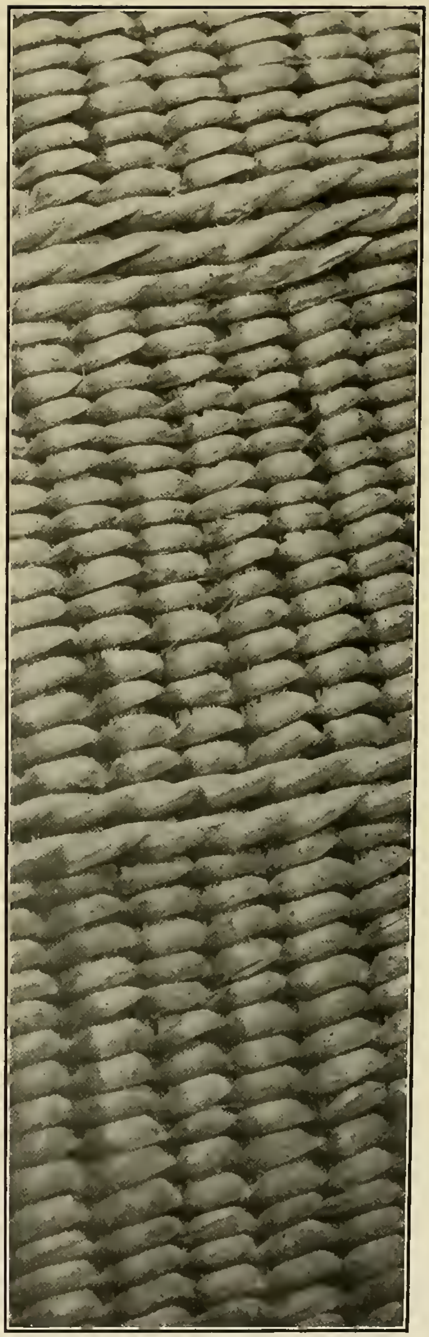
Illustrations of plait in Hinai poepoe.



A



B



C

PLATE VII.

7651 Cover of the ieie basket, No. 7651, shown in text.

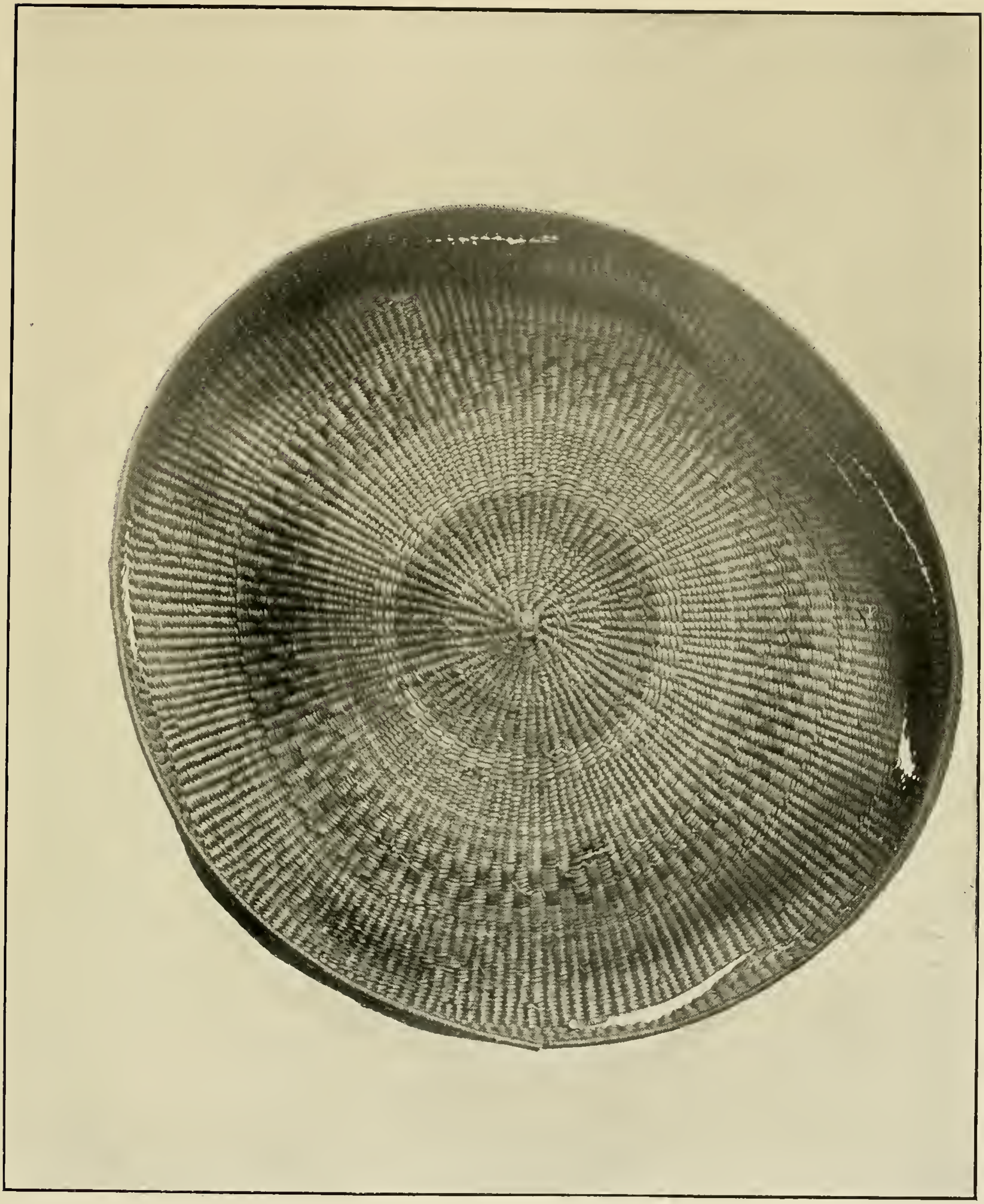


PLATE VIII.

1409 Basket covering of a gourd.

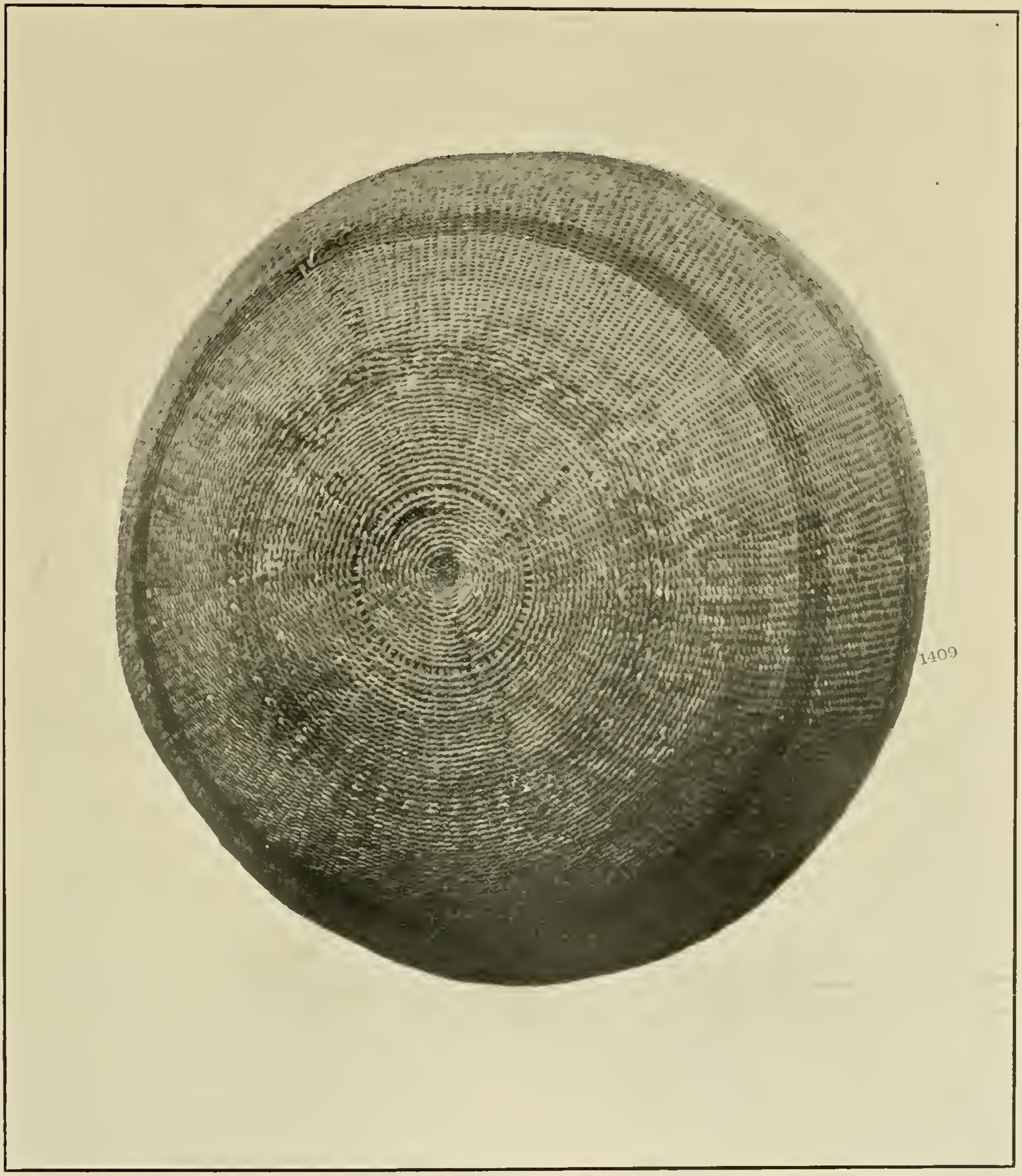

1409

PLATE IX.

3889	Hinai poepoe of ieie around a wooden umeke.
3890	Hinai poepoe with cover, both around wooden umeke.
1404	Decorated Hinai poepoe around gourds.

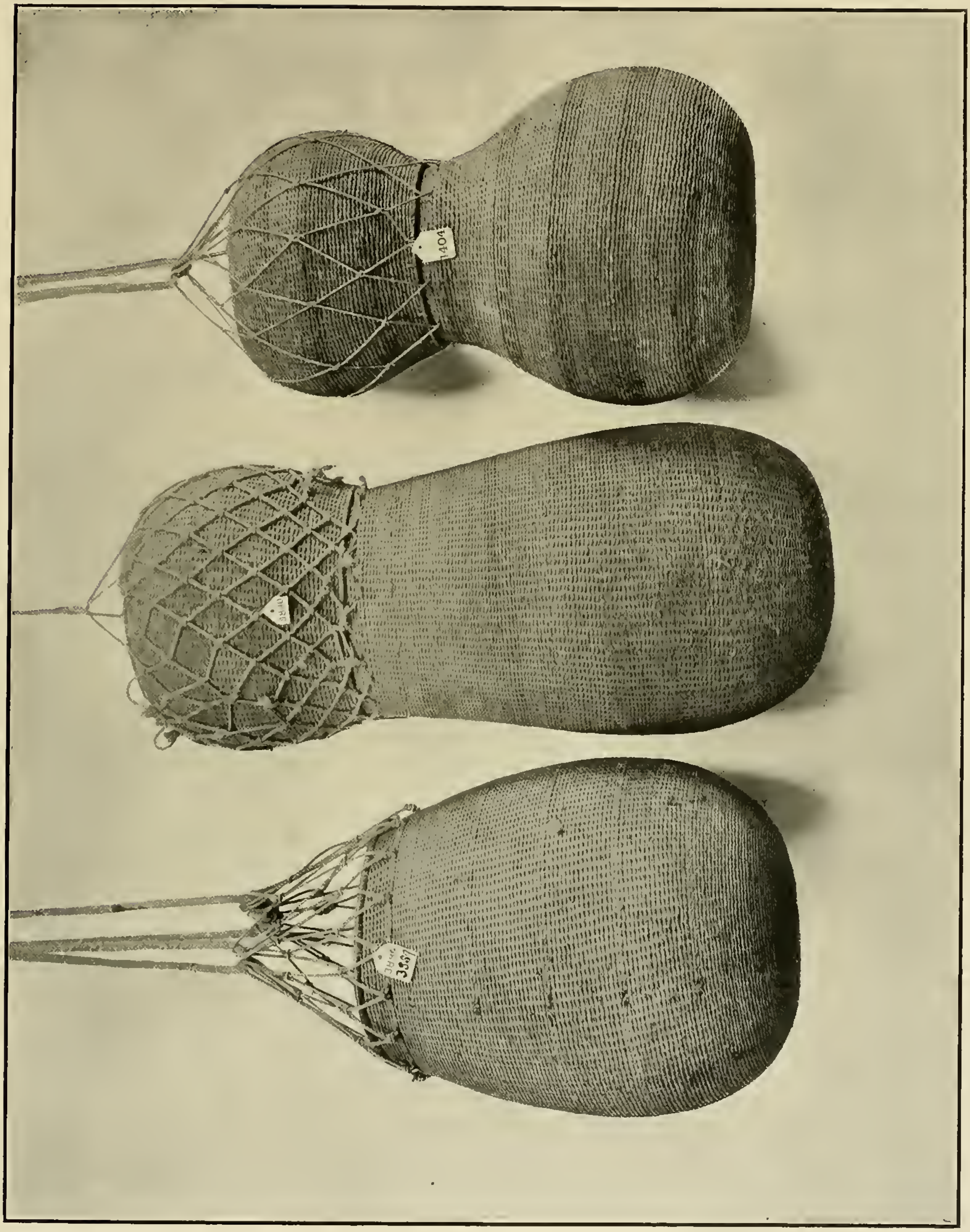

1404

PLATE X.

The beginning of a Makaloa Mat.

Plate X.

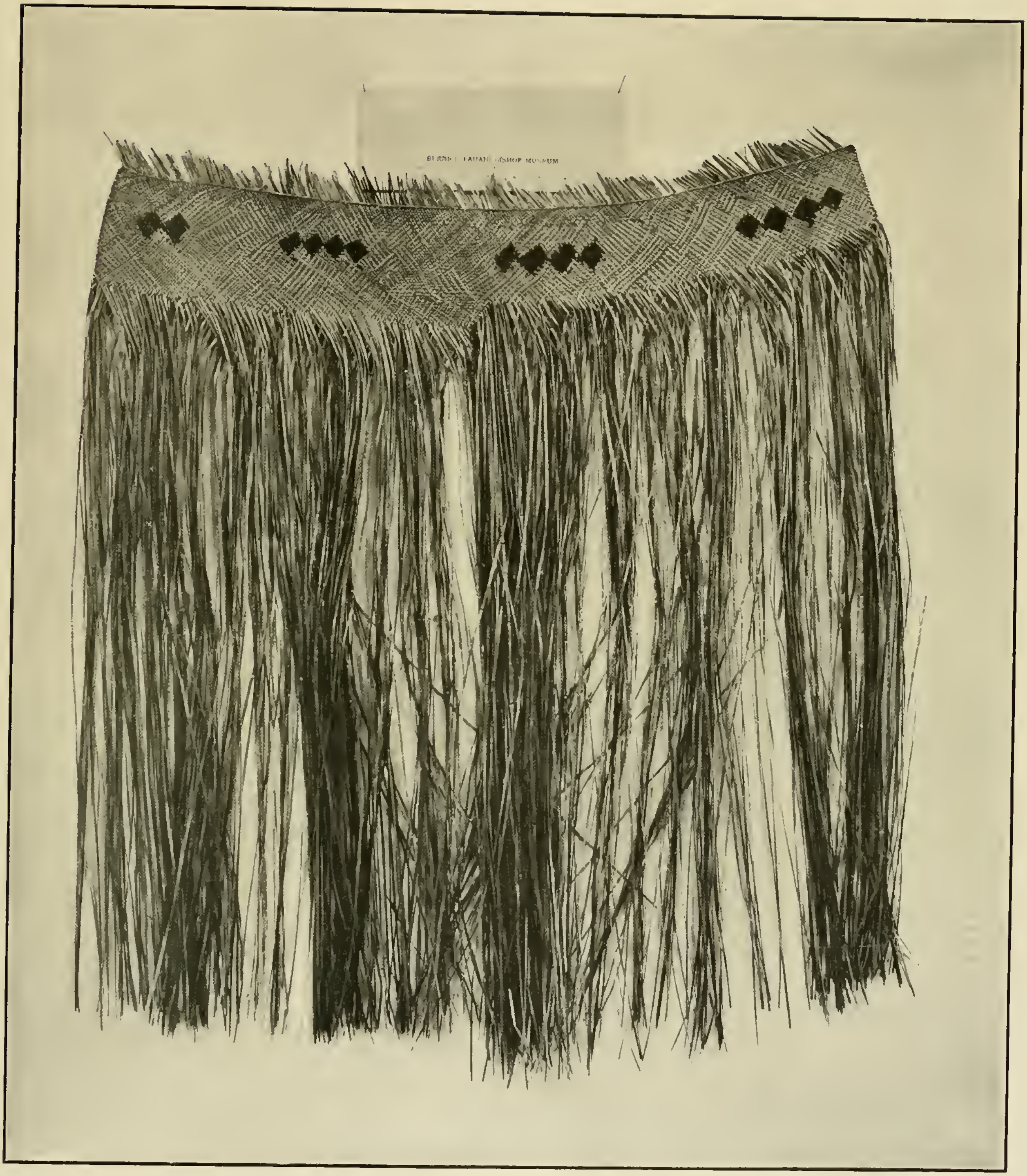

BERNICE PAUAHI BISHOP MUSEUM

PLATE XI.

Portion of a Niihau or Makaloa Mat.

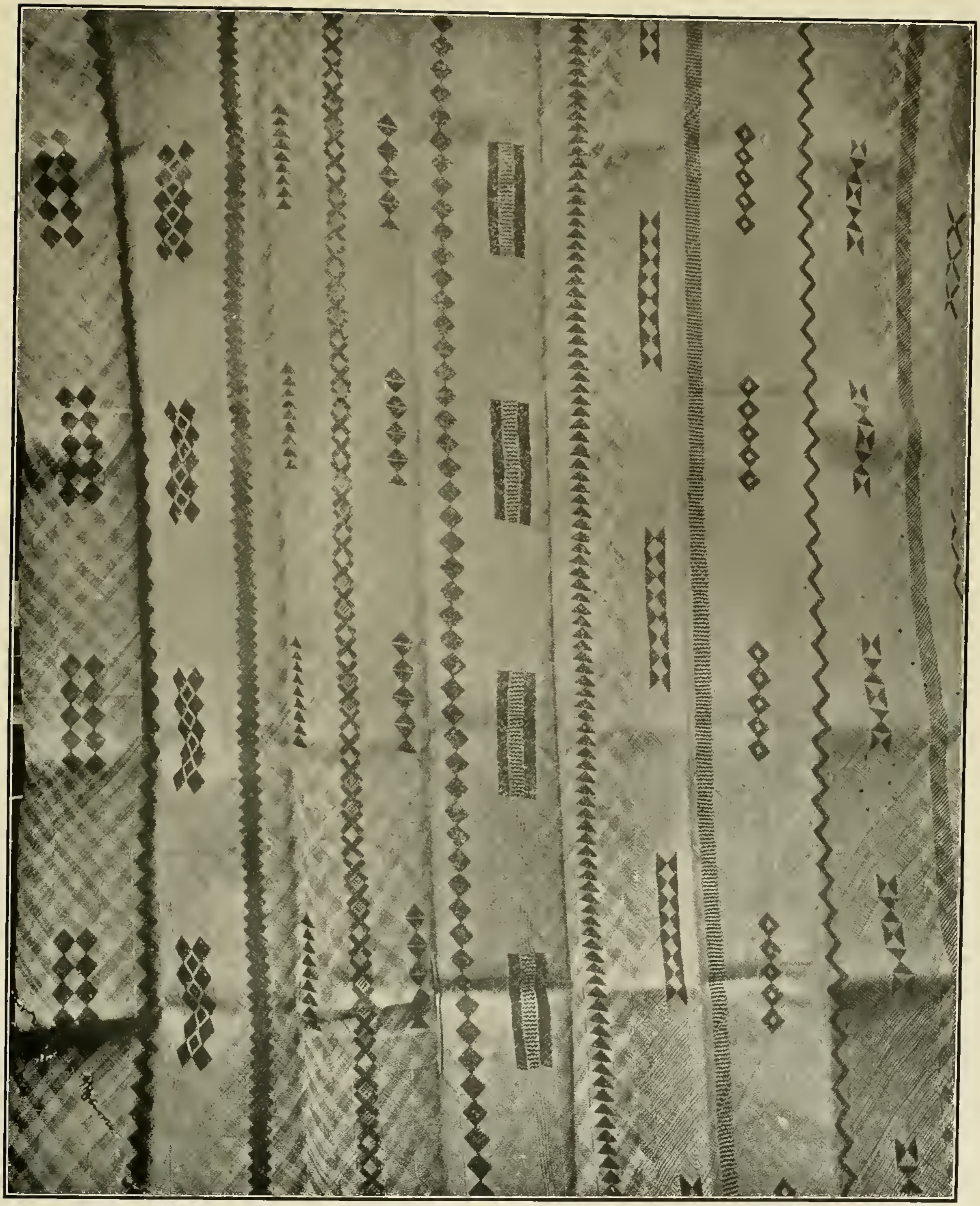


PLATE XII.

Portion of a Niihau or Makaloa Mat.

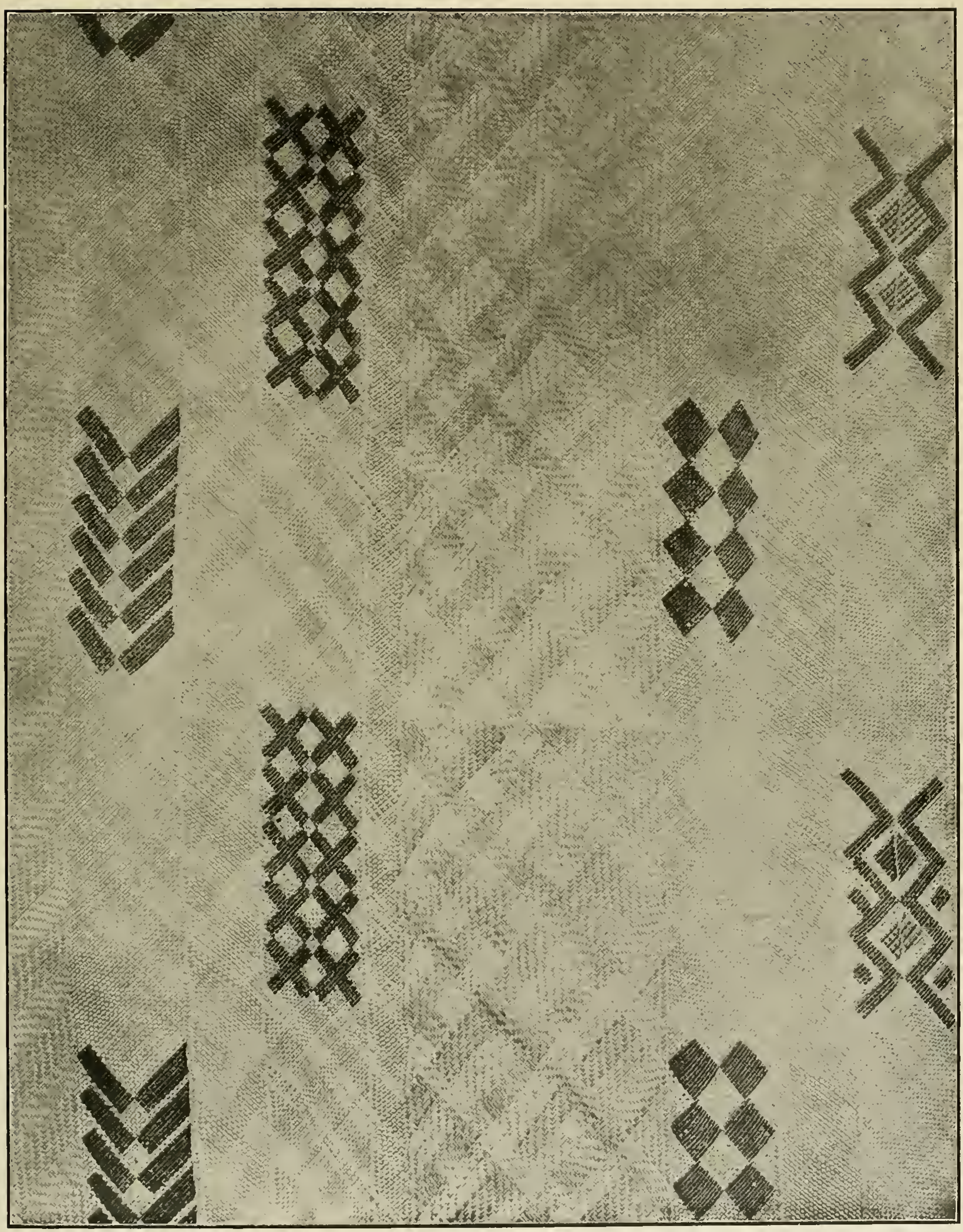


PLATE XIII.

Portion of a Niihau or Makaloa Mat.

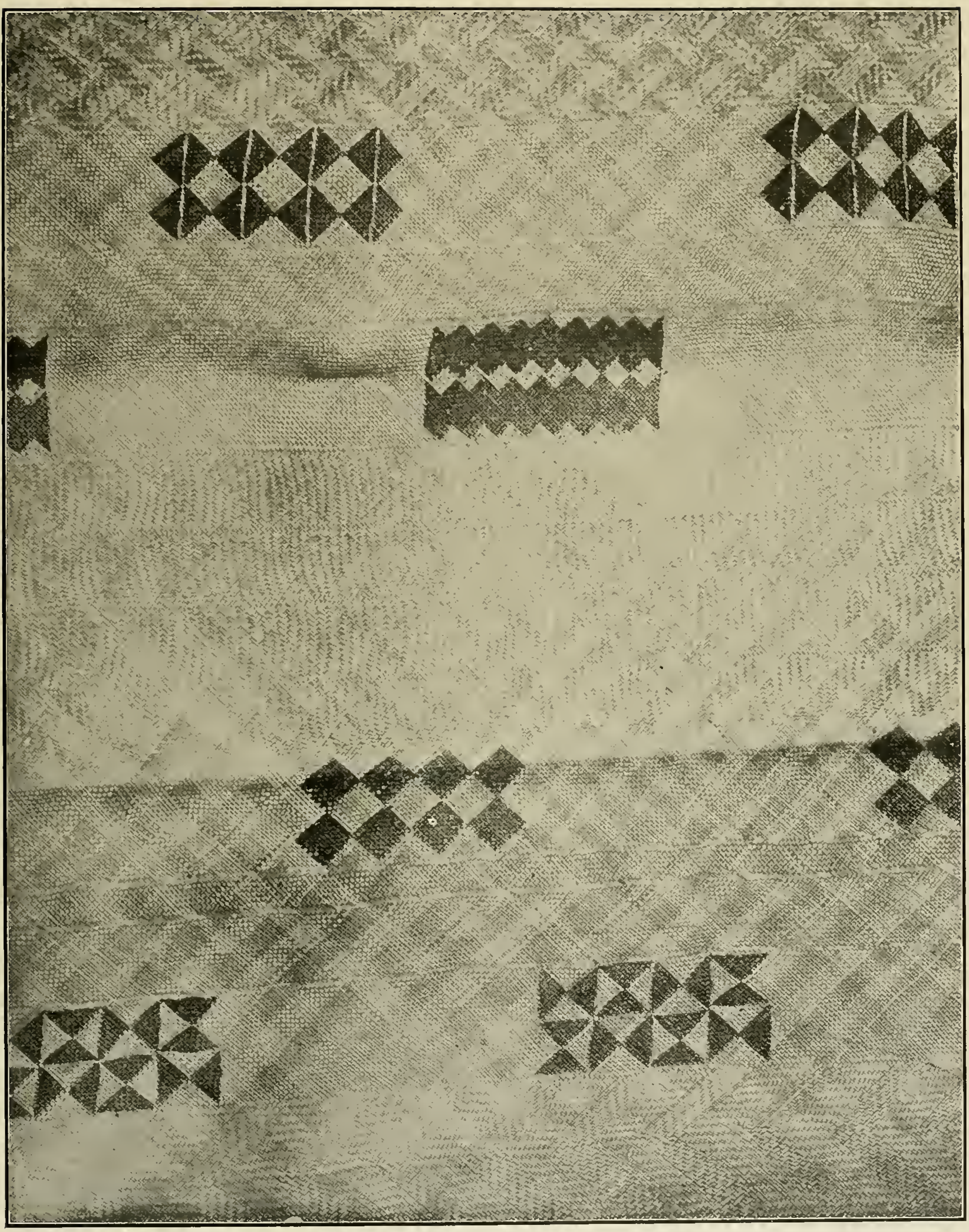


PLATE XIV.

Group of modern Hawaiian Fans with a central one of ancient form.

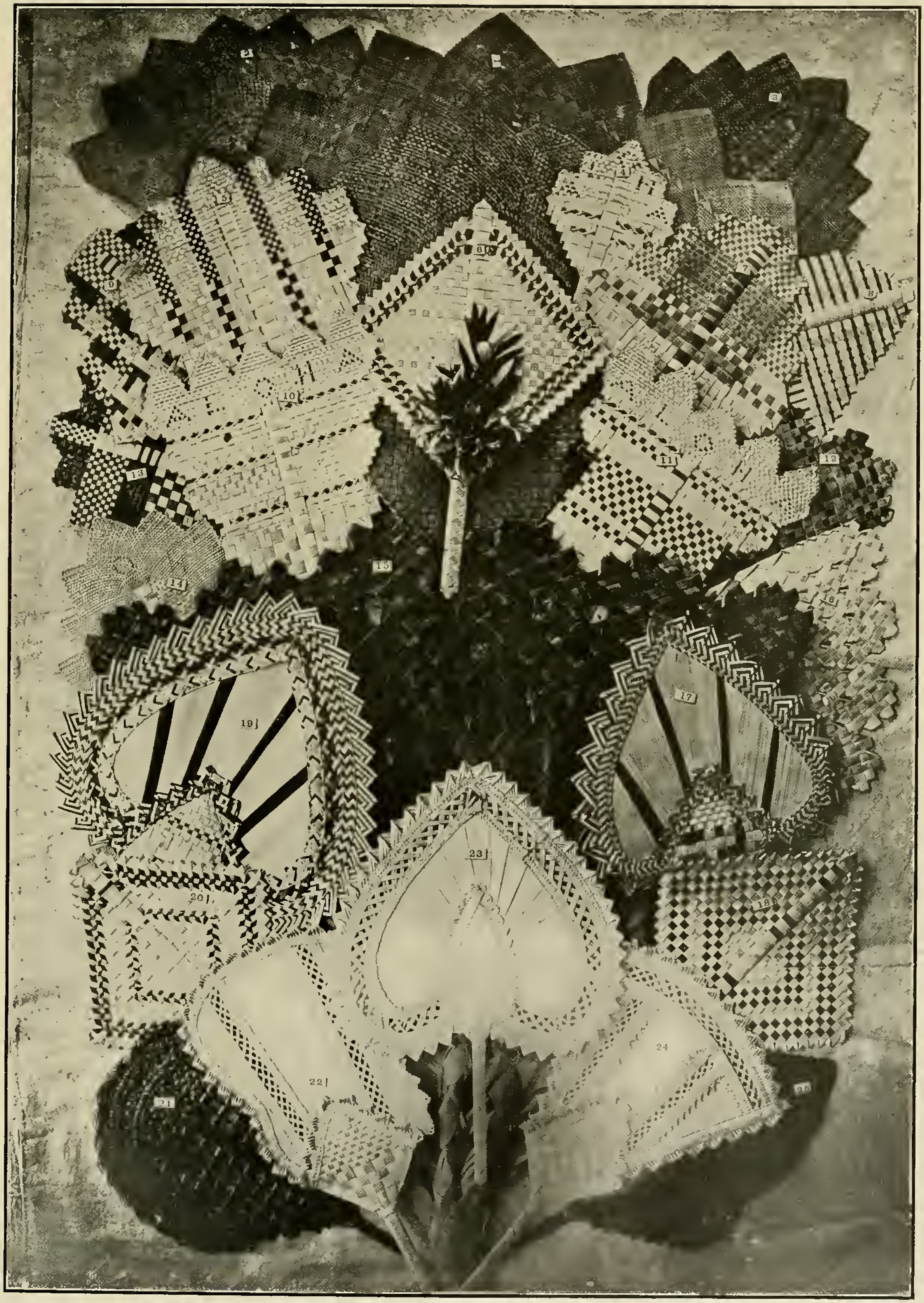
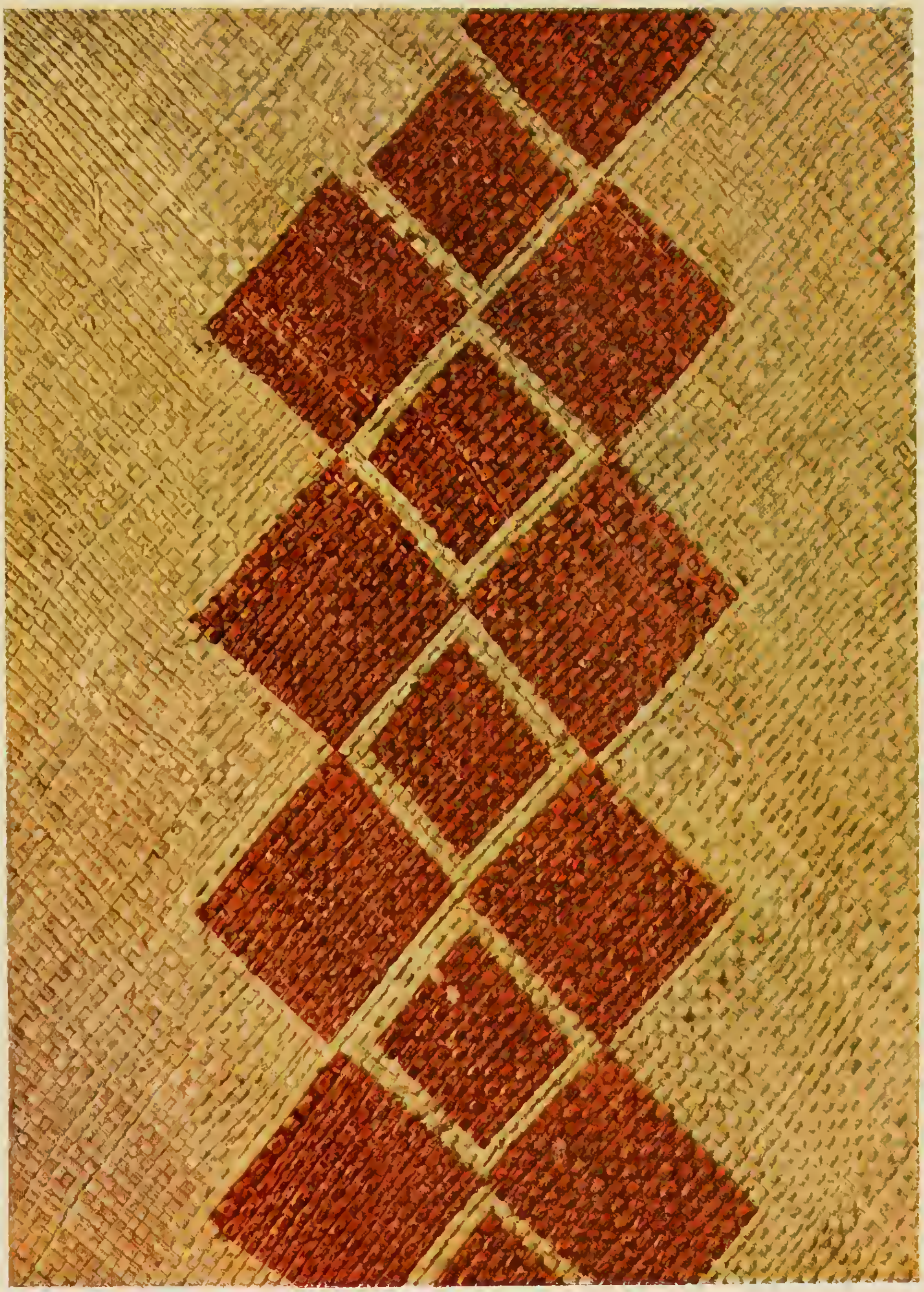
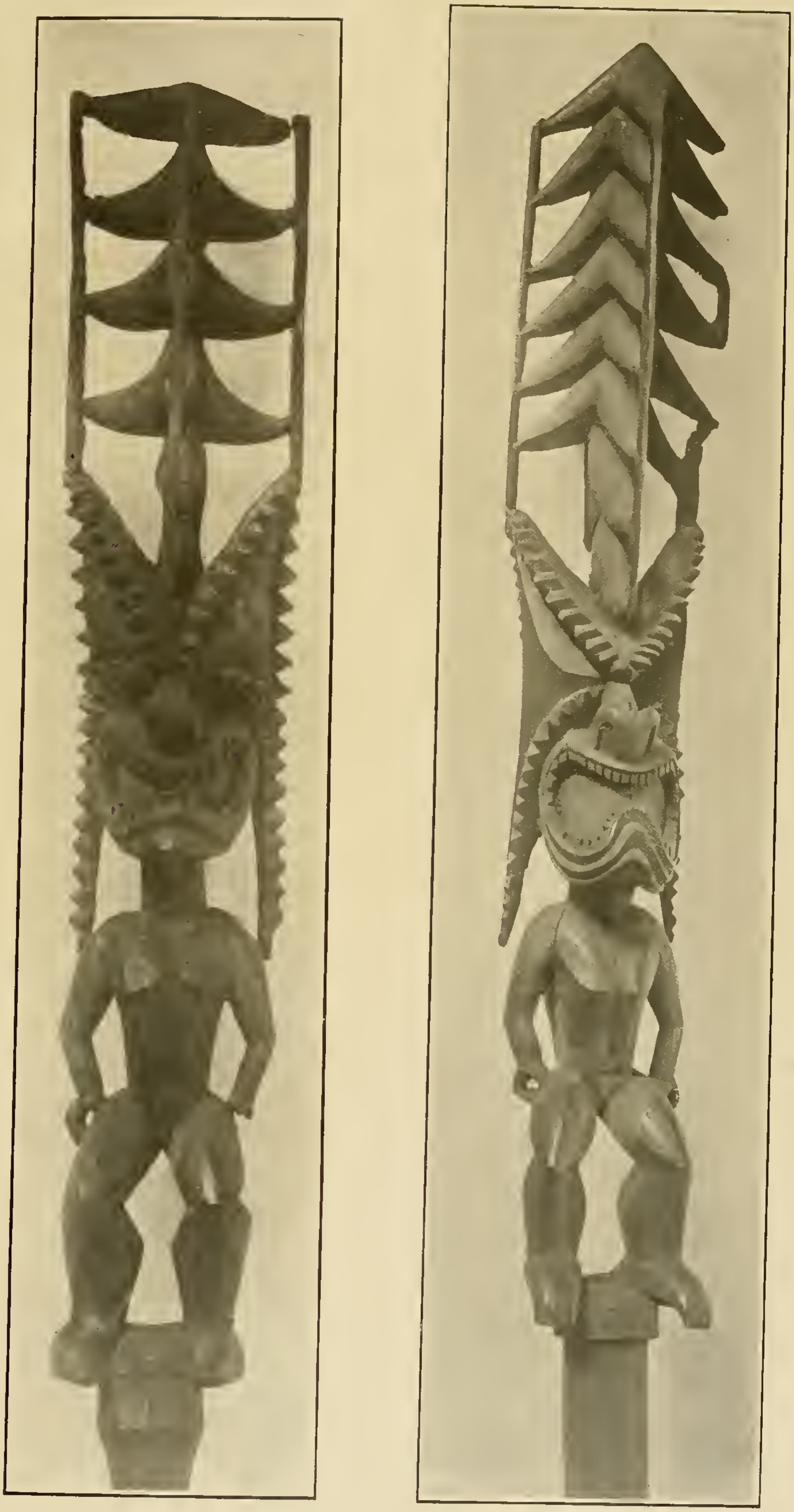

2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

PLATE XV.

A figure of a Hawaiian, cast from life by the sculptor Allen Hutchinson, to illustrate the ancient method of scraping the fibre of oloná in the cord and net manufacture. Made for the Bernice Pauahi Bishop Museum. The background shows the case containing fishing implements.



MAKALOA MAT.



ENLARGEMENT OF THE CARVED PORTION OF TWO AUMAKUAS.

PLATES.

PLATE XVIII.

A view of Pagopago Harbor, near the entrance, with typical Samoan house. The photograph was taken many years ago by Jos. Martin of Auckland. The present village is situated beyond the field of this view.

PLATE XIX.

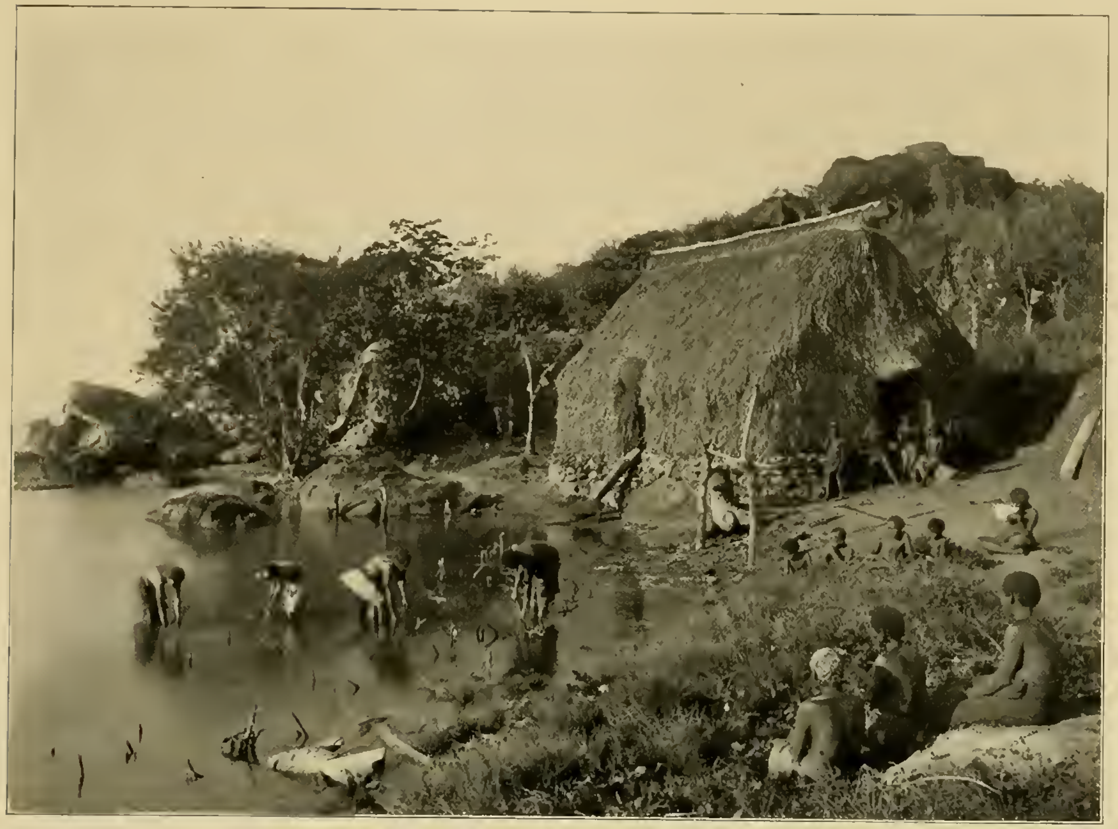
The King's house at Mbau, Fiji. Modern influences are shown in the windows on each side of the door; also in the raised garden house. The fence is a good specimen of the Fijian barriers placed around their gardens or plantations.

Waitovu Village, Ovalau, Fiji. The stone platforms on which the houses are built are well shown. The wide spreading growth of the breadfruit tree, when planted near the dwellings is seen in the upper part of the view. Photographed by J. W. Lindt of Melbourne.

PLATE XX.

Na Kali Village, Viti Levu Bay, Fiji. One of Lindt's most charming views. The house occupies the entire extent of the stone platform, and shows the pent over the doors, the steep log ladder at the water side, and the method of fastening the thatch over the ridge pole. J. W. Lindt, Photo.

Doorway of a Fijian house, showing the fence to keep out small animals. J. W. Lindt, Photo.



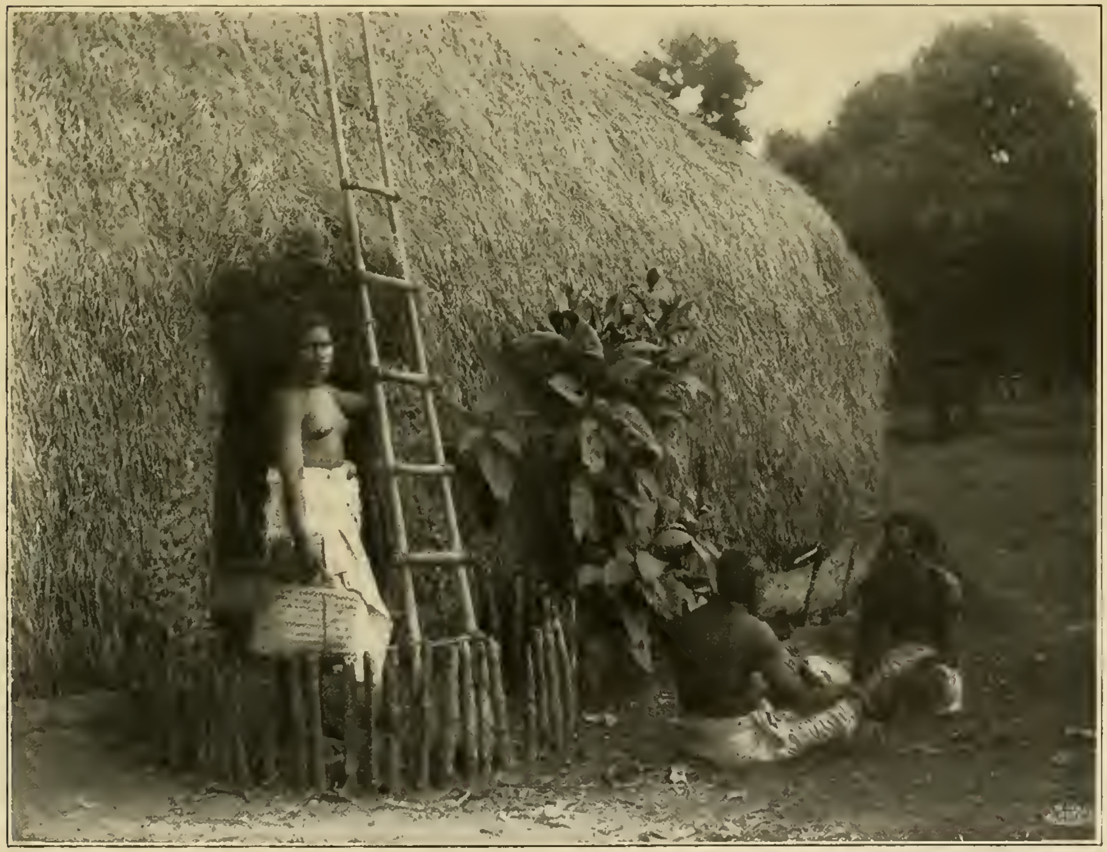


PLATE XXI.

Maori carved house. The carved figures on the barge-boards are remarkable.

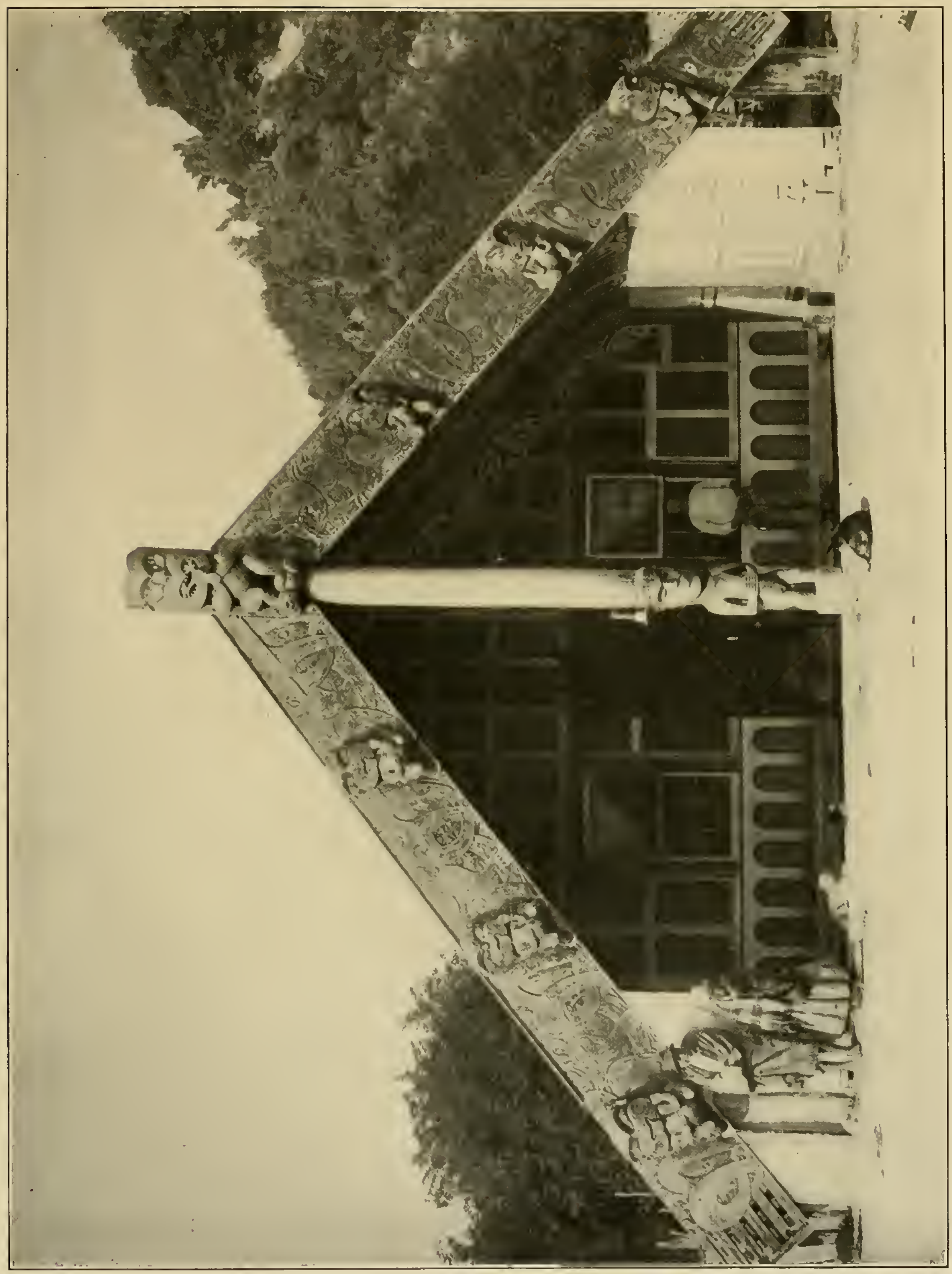
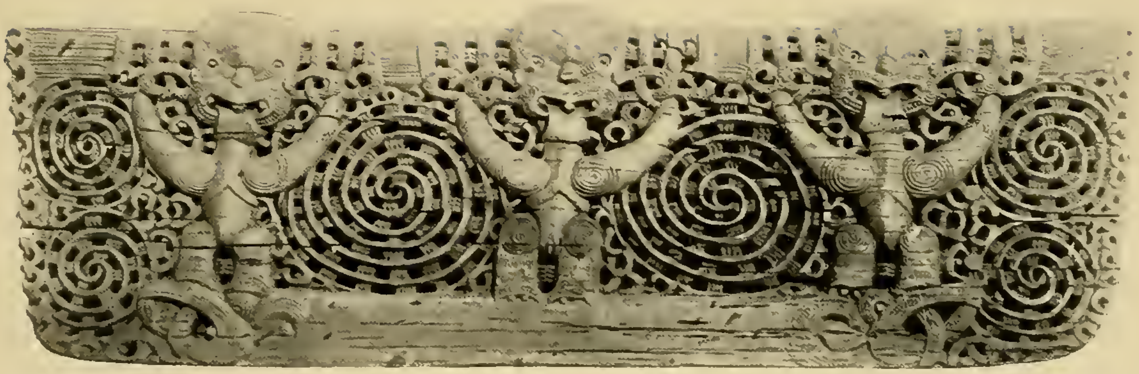


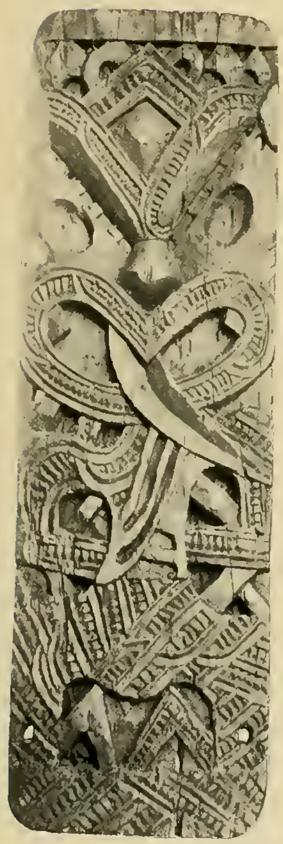
PLATE XXII.

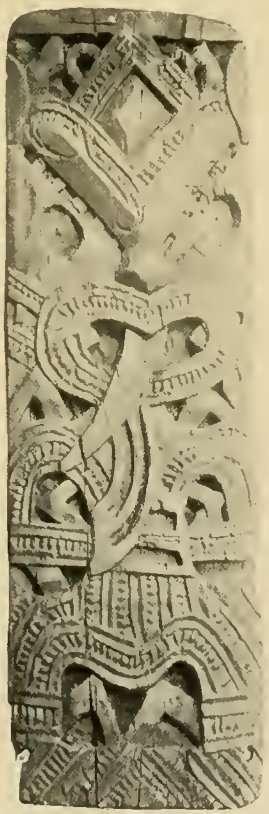
Pare from Runanga Whare, Morea, Lake Rotoiti. Museum No. 1516.

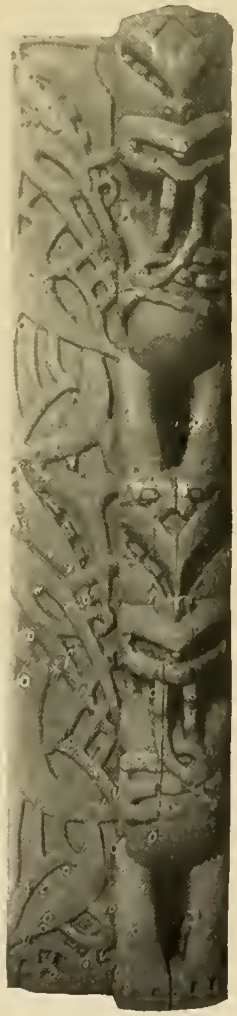
Pair of Ama, Tarawera. Museum Nos. 1418, 1419.

Ngawaewae from Tetaheko, Lake Rotoiti. Museum No. 1415.









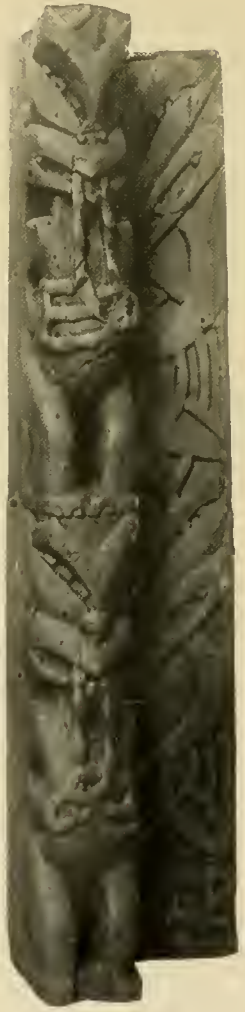
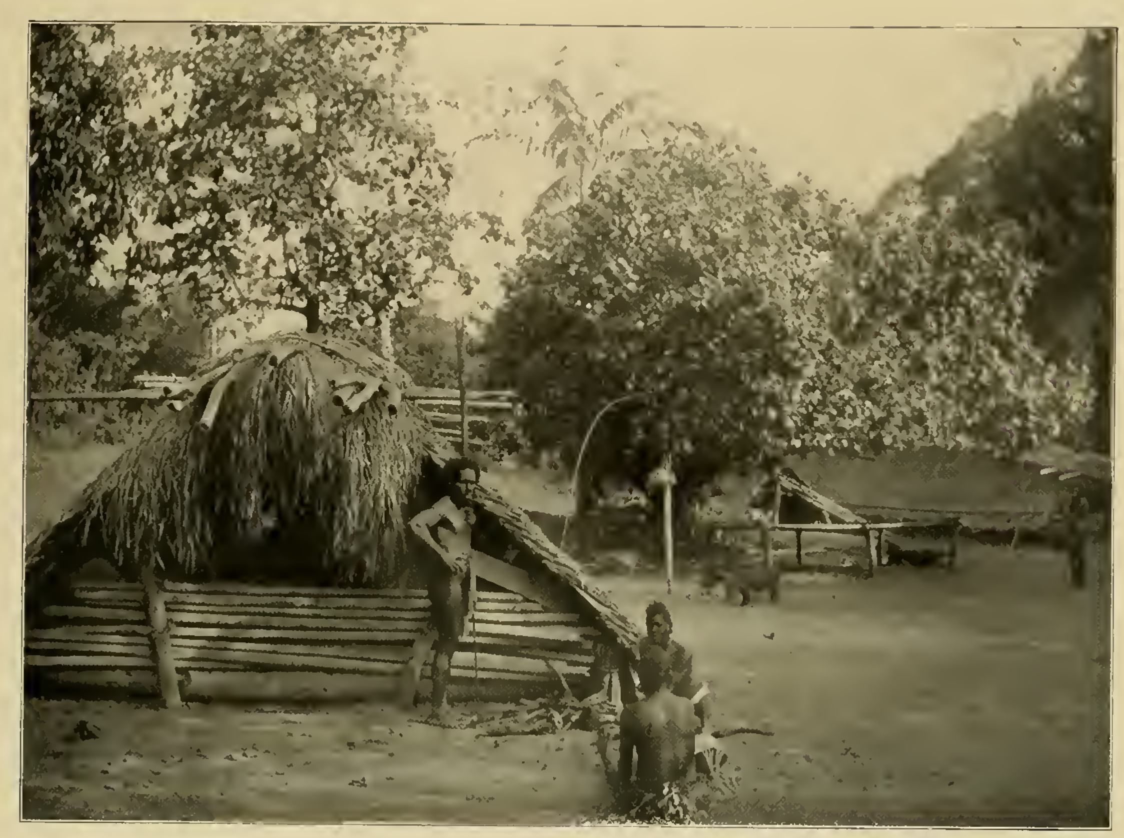


PLATE XXIII.

New Hebridean Huts.



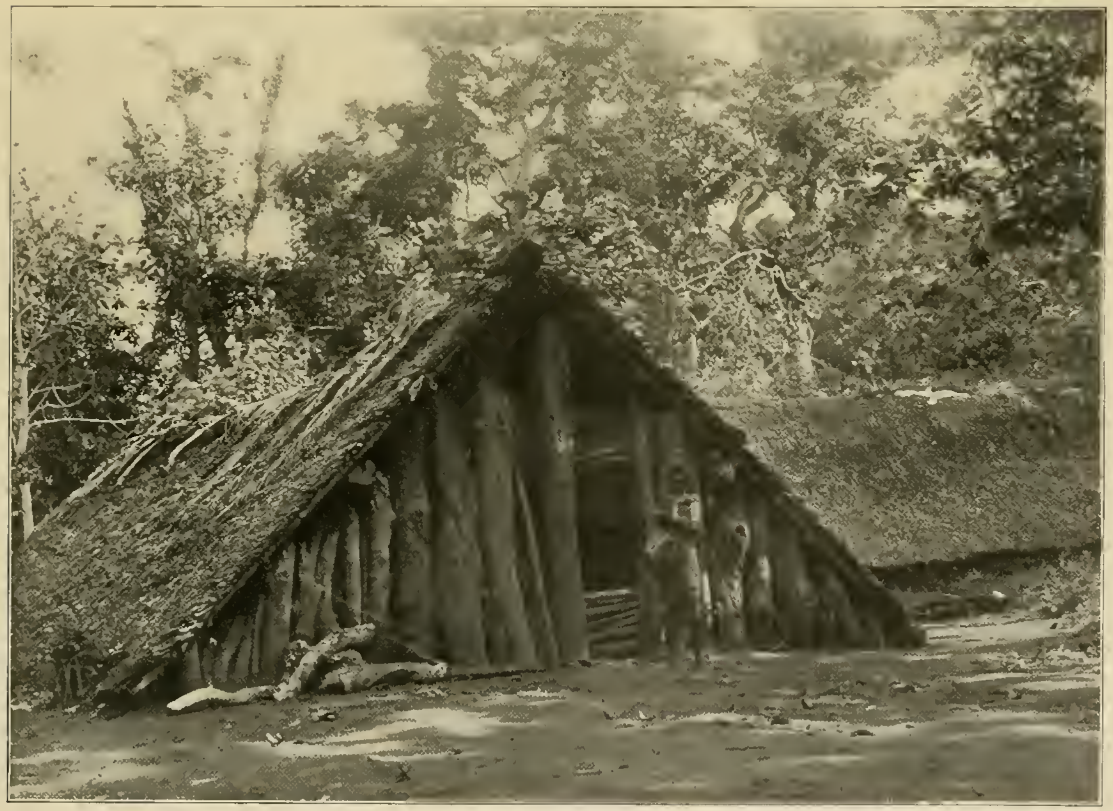


PLATE XXIV.

Front of communal house in British New Guinea. It is raised on piles as if built in water.

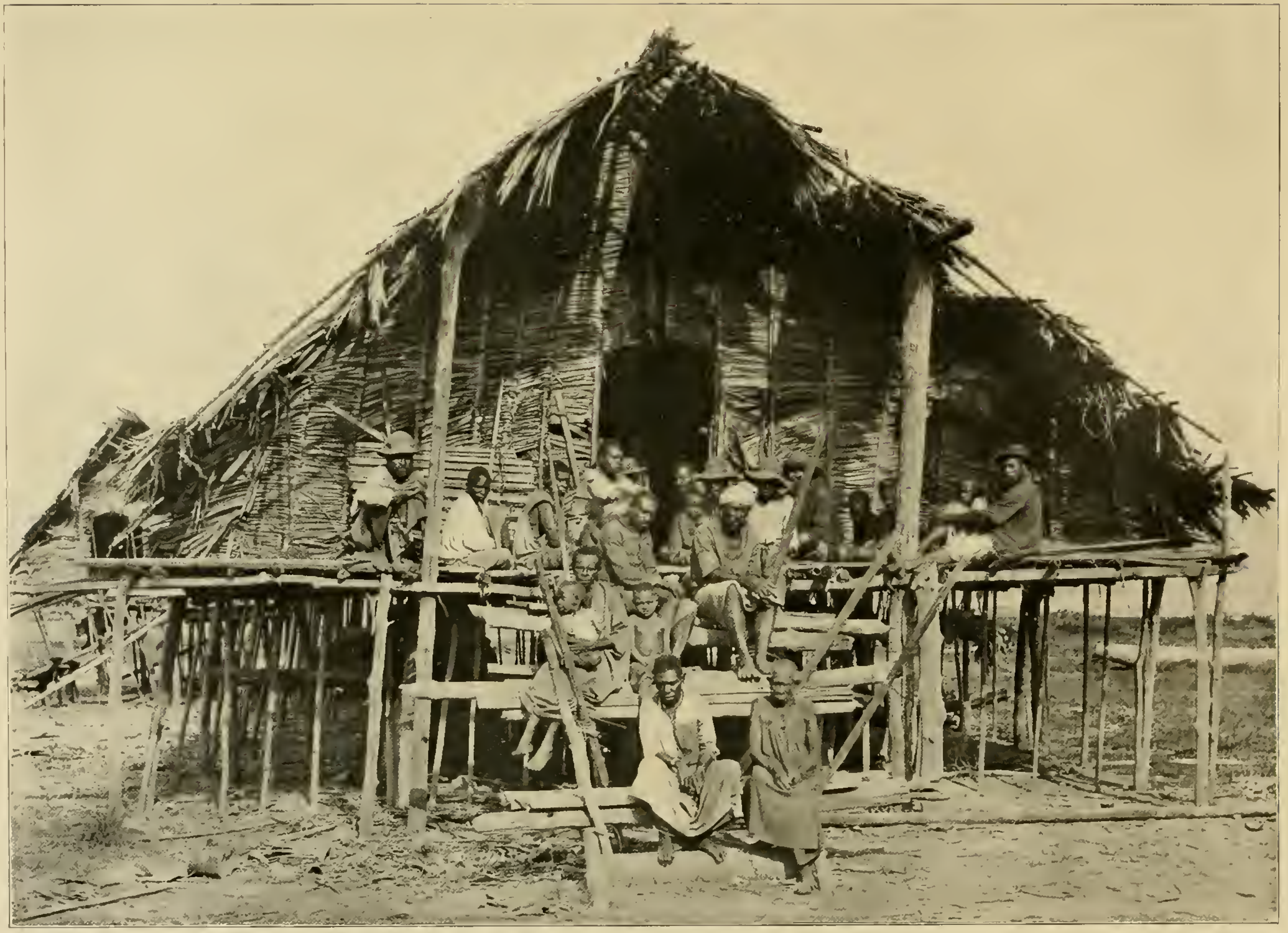


PLATE XXV.

High house in New Guinea Village.

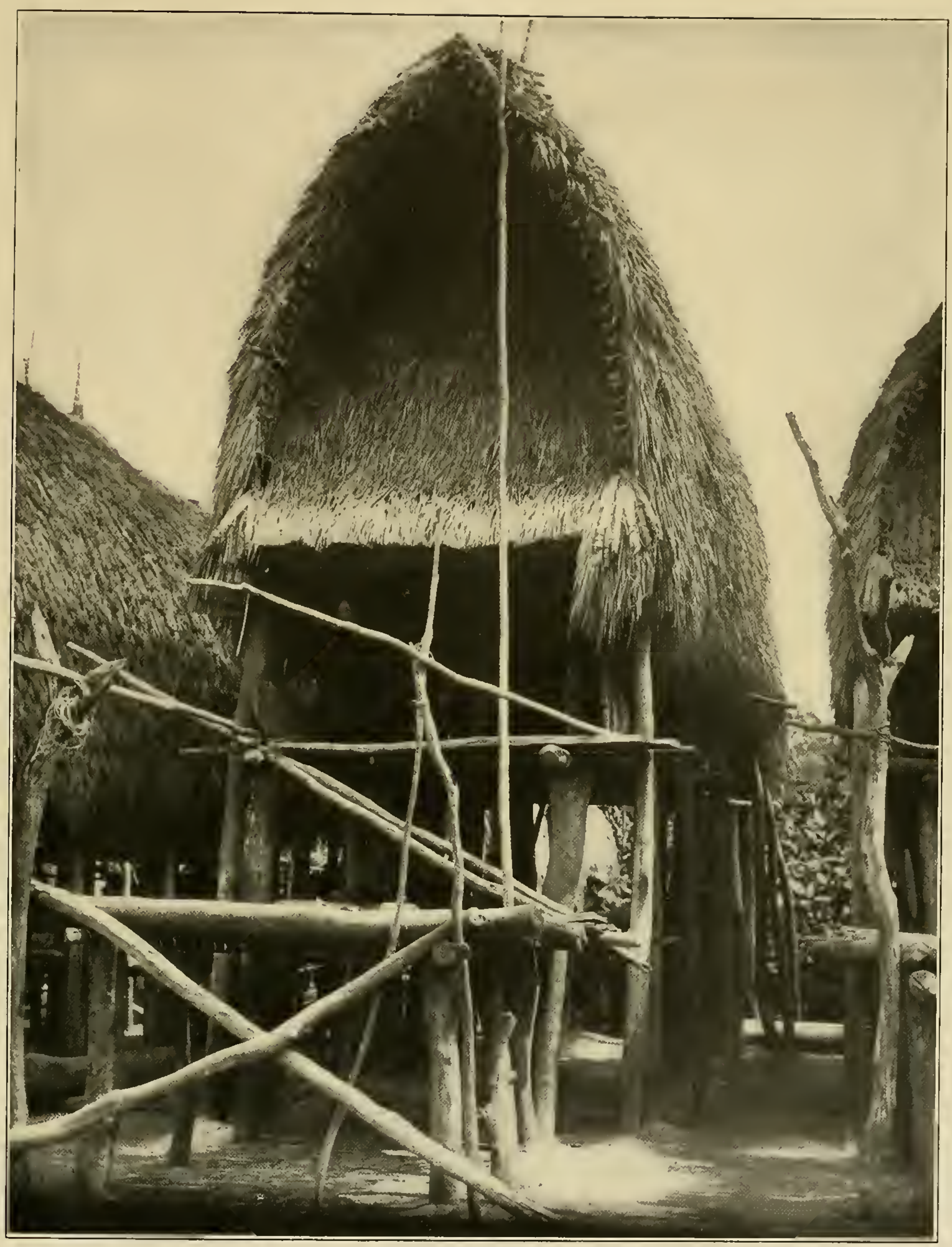


PLATE XXVI.

Old Hawaiian house frame being rebuilt in the Bishop Museum. The temporary supports are used instead of scaffolding owing to the stone floor on which the house is placed.

Plate XXVI.

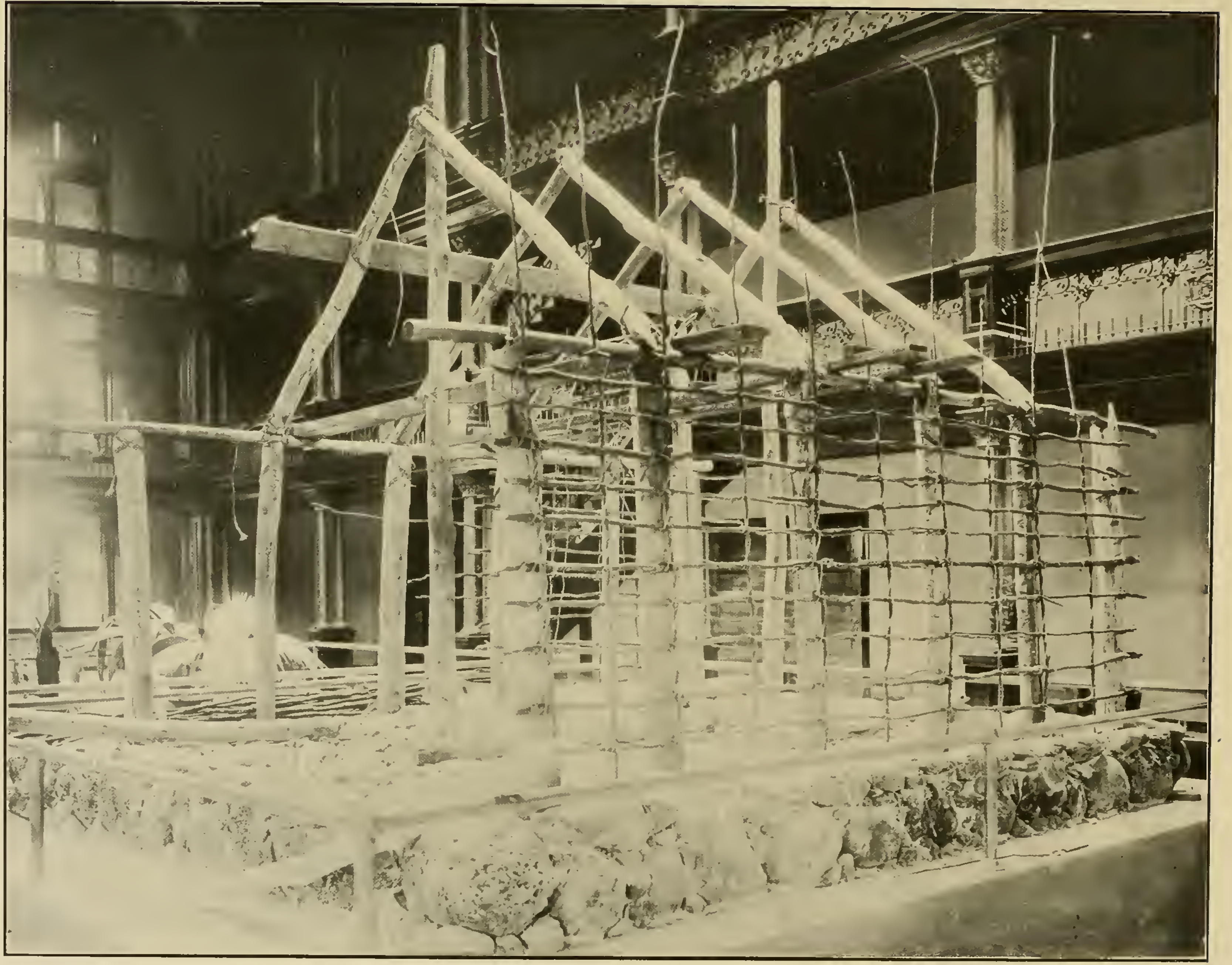


PLATE XXVII.

Hawaiian house in the Bishop Museum showing the beginning of the thatching on the front side.

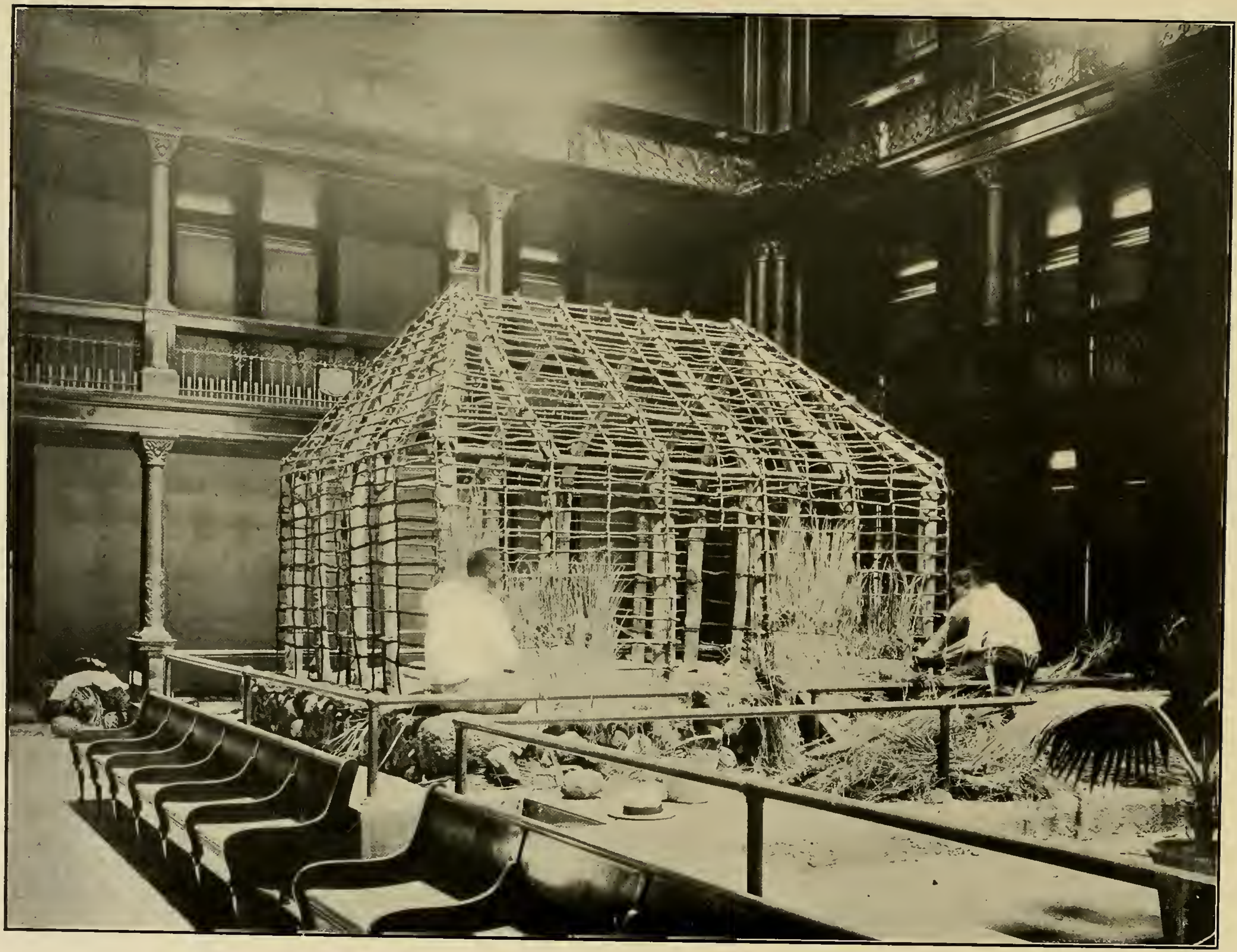


PLATE XXVIII.

Hawaiian house in the Bishop Museum completed. Showing the bonneting above the ridge-pole, and the hakakau.

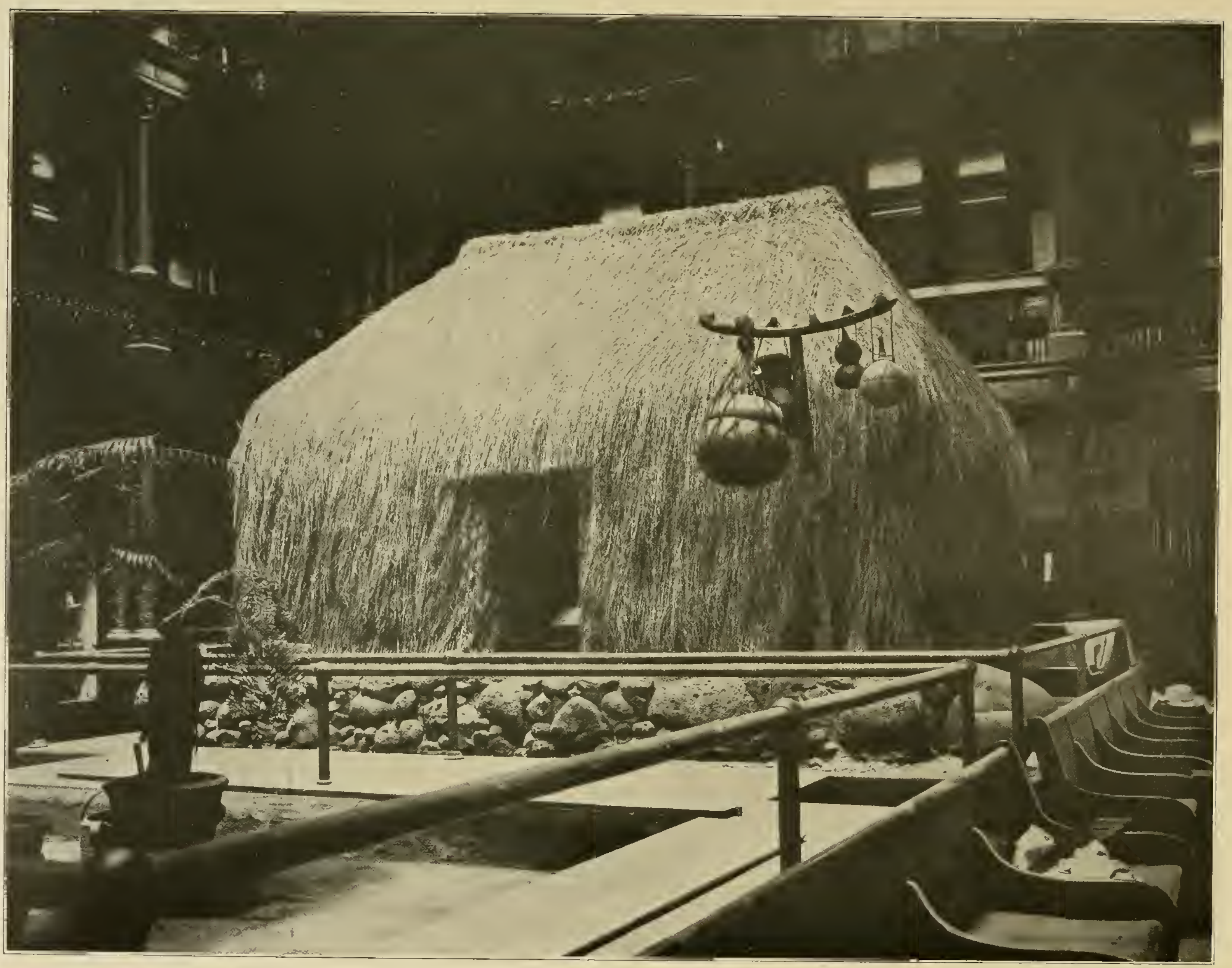


PLATE XXIX.

Hawaiian Cords and Braids.

1 Aha hoa waa: coconut fibre braid used for attaching the outrigger to a canoe. 4749.
2 Coconut fibre two-ply cord used for koko umeke.
3 Coconut fibre braid used to fasten the upper parts of a canoe. 4750.
4 Coconut fibre braid from fine coil. 6842. See Fig. 70.
5 Coconut fibre braid. 4751.
6 Coconut fibre braid. 5038.
7 Coconut fibre braid. 4756.
8 Coconut fibre twist. 4756.
9 Oloná square braid, used for strangling cord.
10 Oloná square braid.
11
12 Ukiuki braid used in building house in Bishop Museum.
13 Human hair cord.
14 4759.
15
16 Oloná fishing line. 3880.
17 Oloná cord fishing line. 772.
18 4578.
19 Oloná fine cord for mending umeke, etc. 7682.
20 Human hair square braid.
21 Human hair square braid used for necklaces, etc.
22 Oloná flat braid for strangling cords.

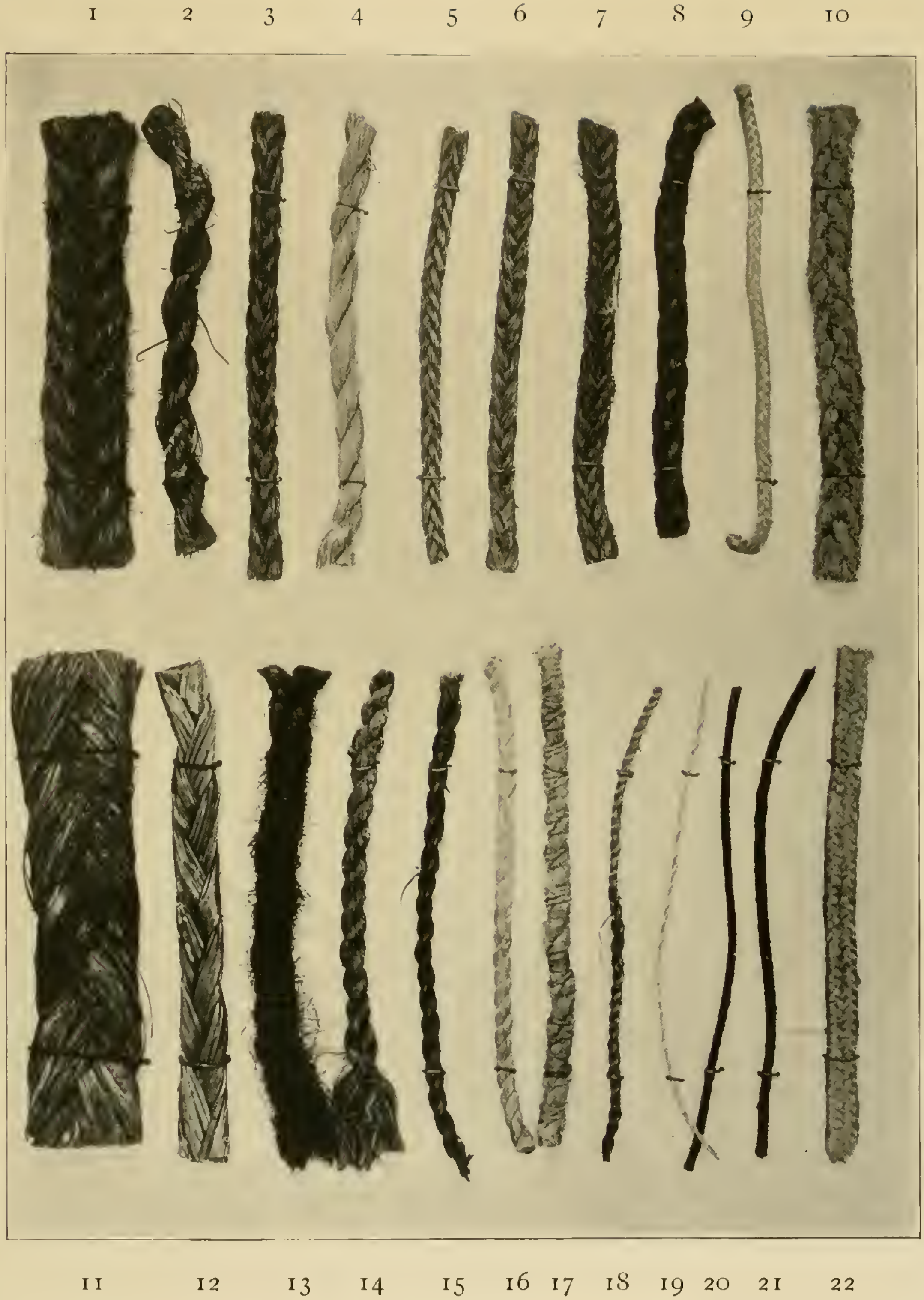

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE XXX.

Ipu holoi lima. Finger bowls.

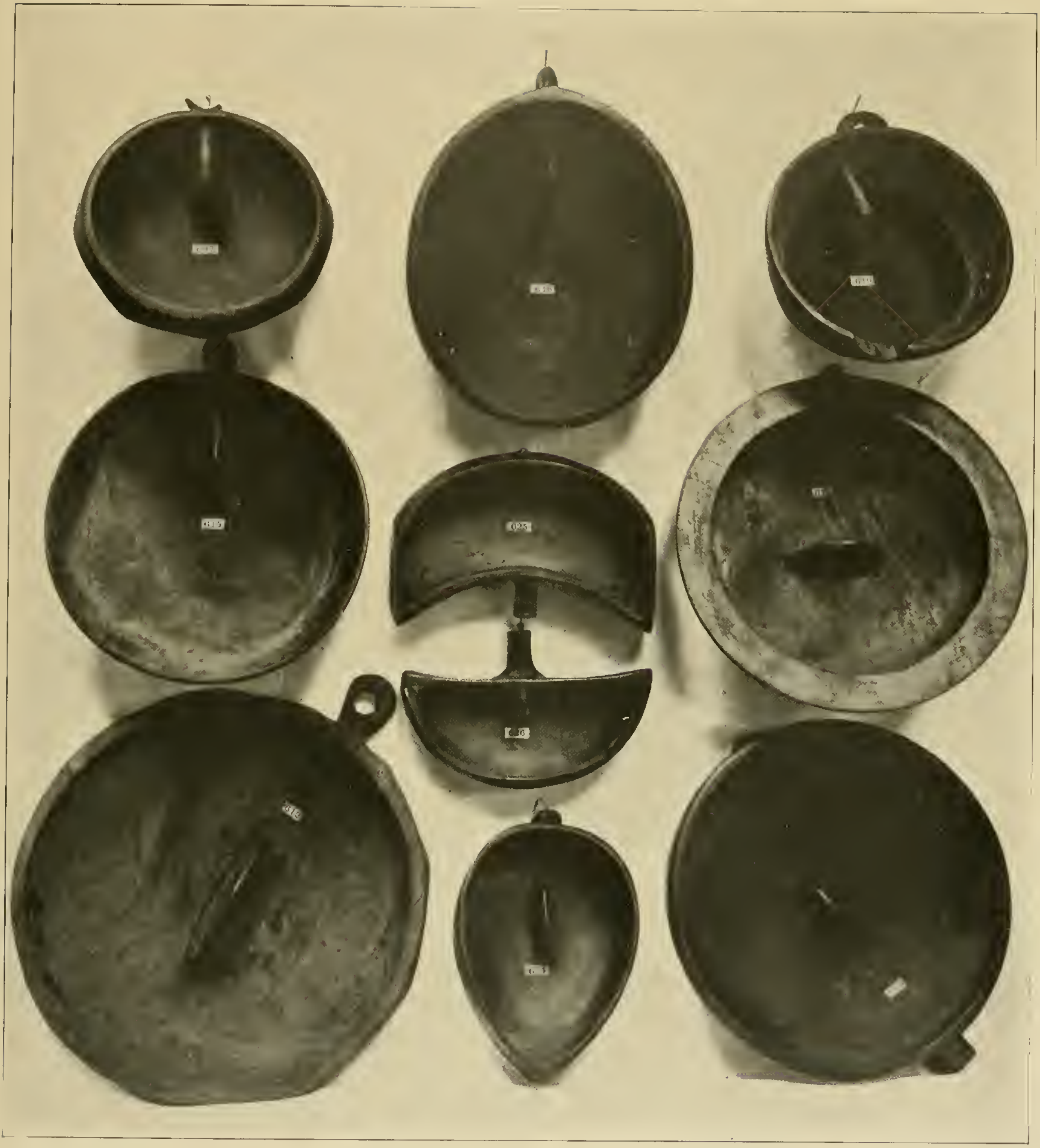


PLATE XXXI.

Ipu aina or refuse bowls with human teeth or bones inserted as a mark of contempt for the owner's enemies whose corpses furnished the teeth.

Plate XXXI.

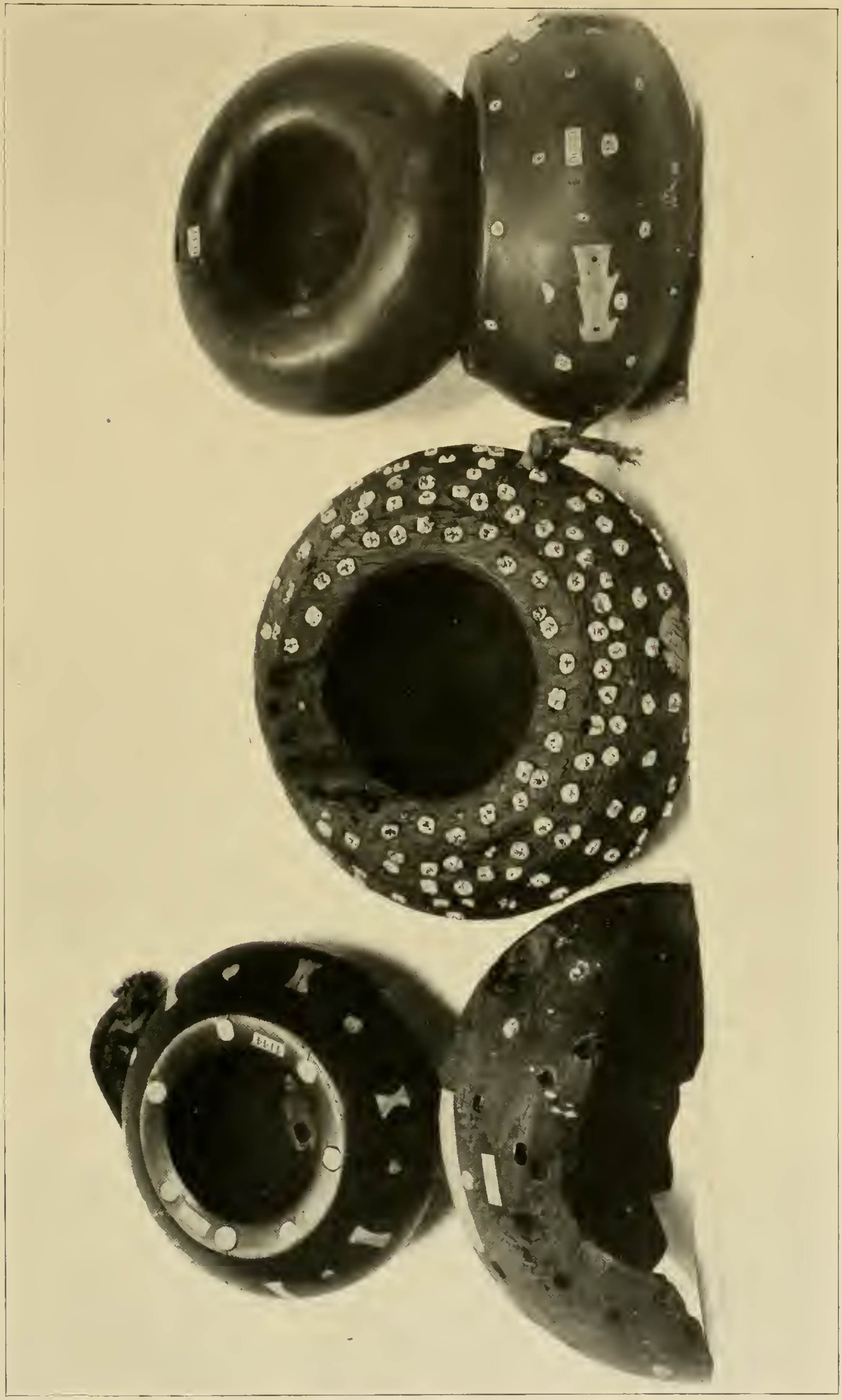


PLATE XXXII.

Ipu kuha. Spittoons.

Ipu mimi. Chamber pots.

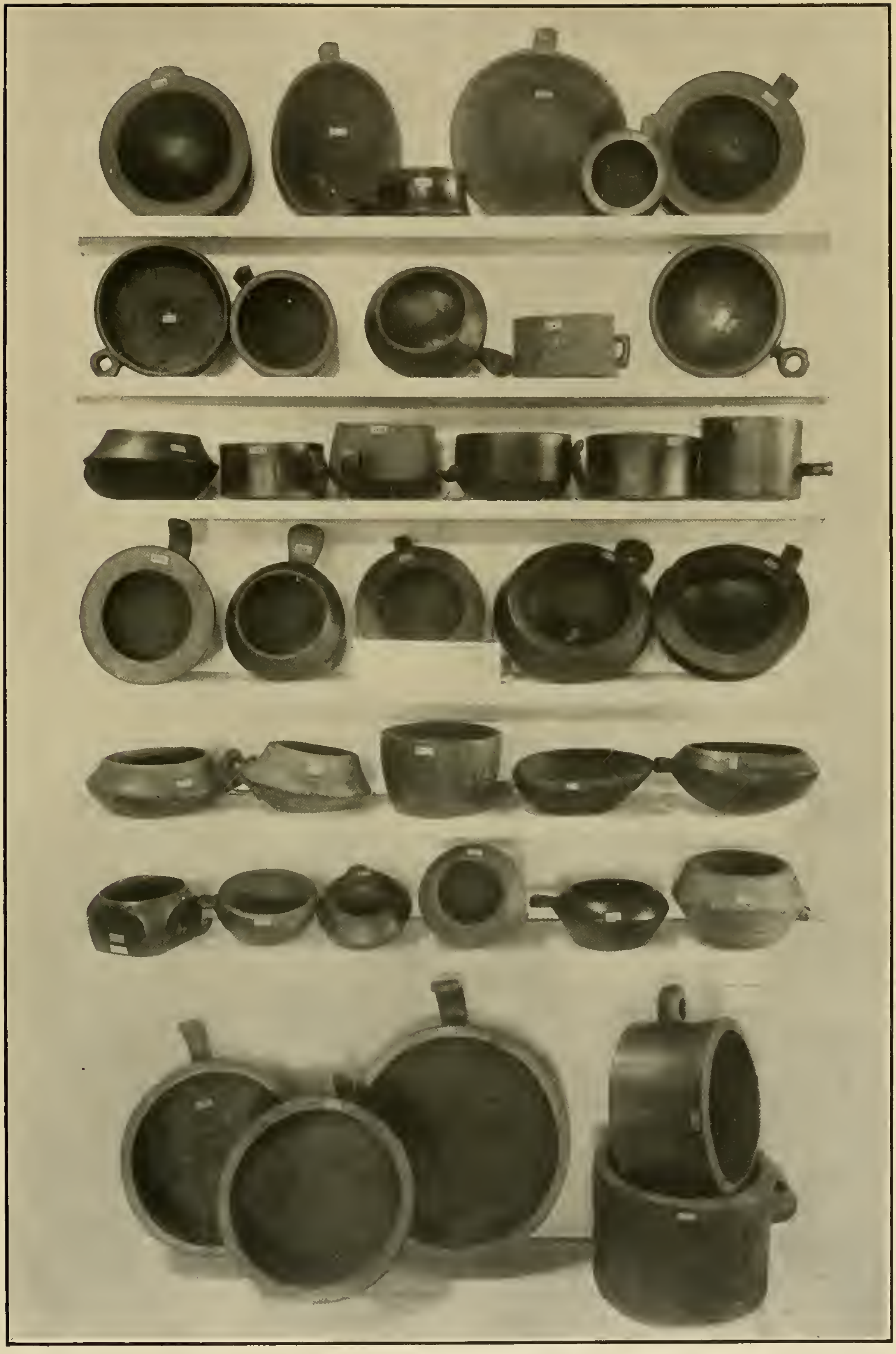


PLATE XXXIII.

Gourd bottles for holding fish lines.

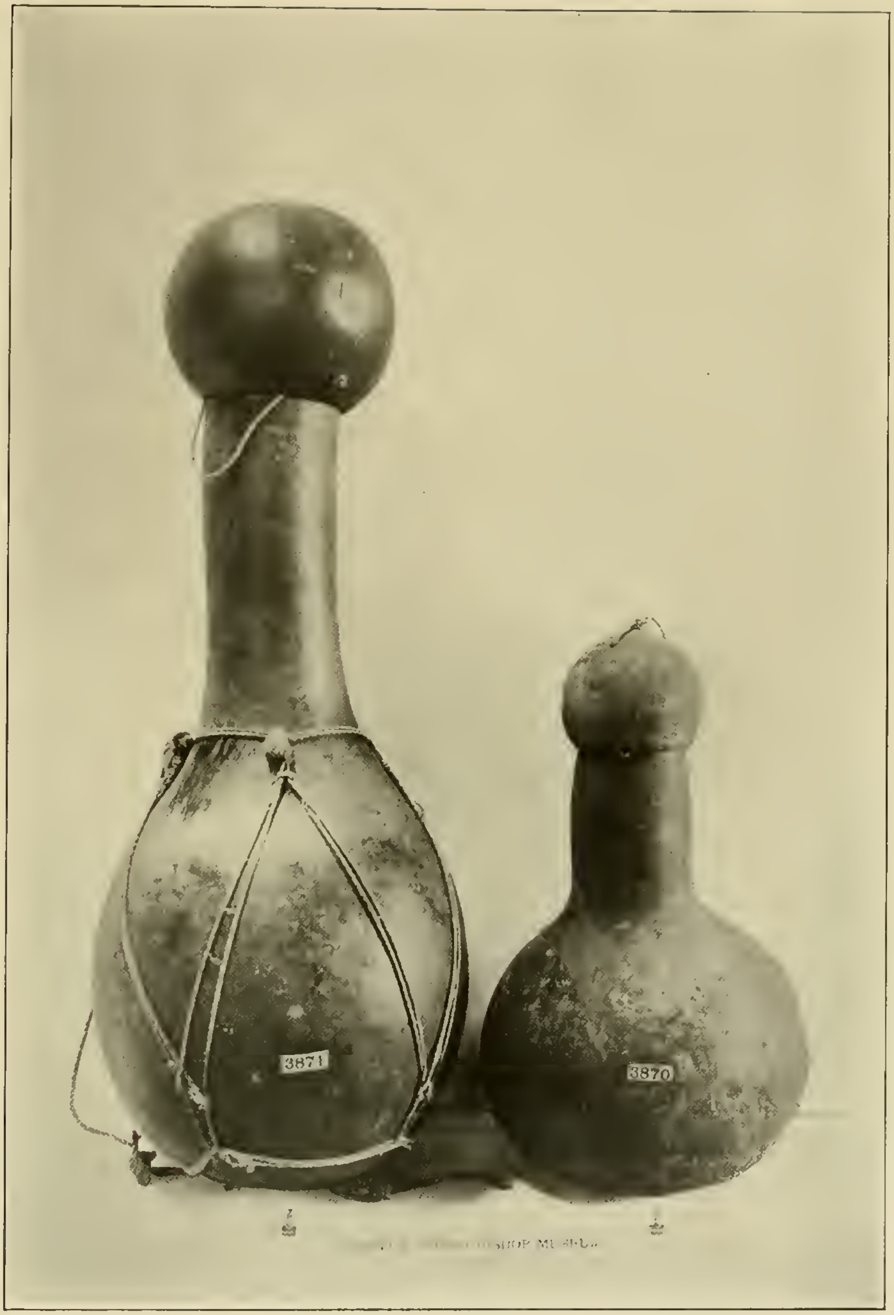

3871
3870
[illegible] BISHOP MUSEUM

PLATE XXXIV.

Hawaiian stirrers for sweet potato poi, and wooden knives (1178–79) for removing the rind from breadfruit, etc.

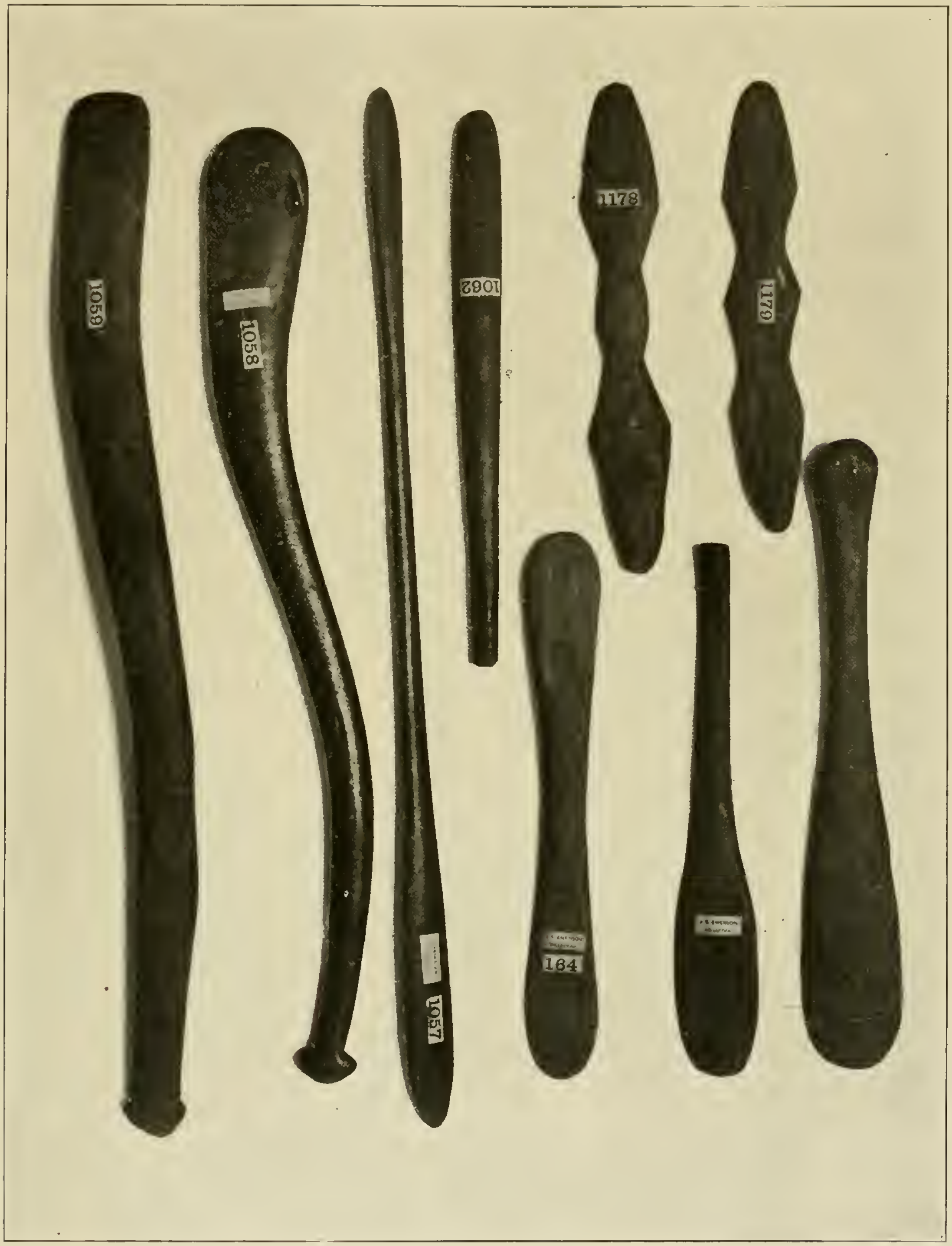

1059
1058
1057
1062
1178
1179
164

PLATE XXXV.

Carved Hawaiian Figures in the British Museum.

A. Umeke supported on figures; the contents can be emptied through the mouth of one of them.

B. Shallow bowl supported on the feet of three figures standing on their hands.

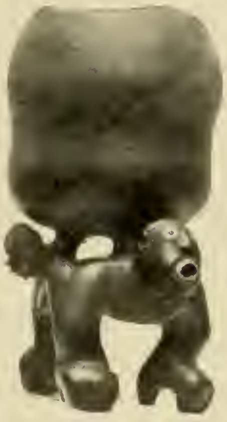
C. A figure connecting two small bowls.

D. Female figure on hands and toes, with uplifted head; for a stool.

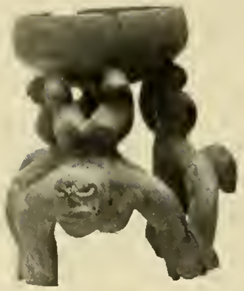
E. Umeke supported by two strangely deformed figures with brutal heads and exaggerated mouths.

F. Spoon or ladle with carved handle.

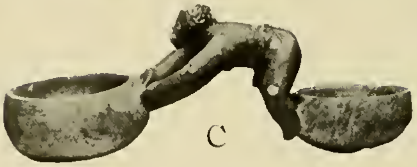
Compare these figures with those shown in Part 2 of this volume.



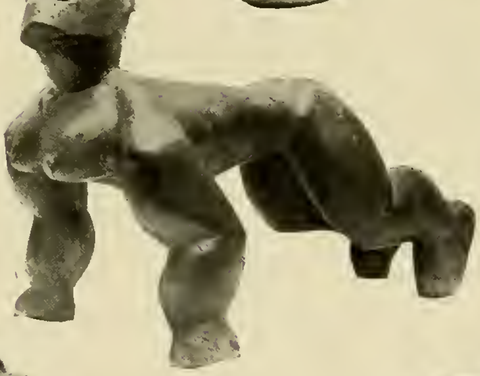
A



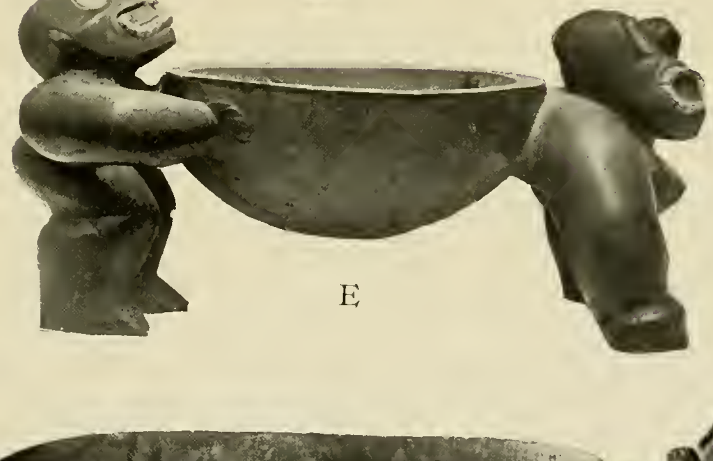
B



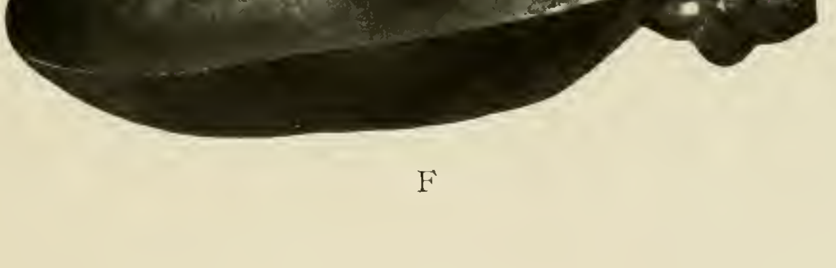
C



D



E

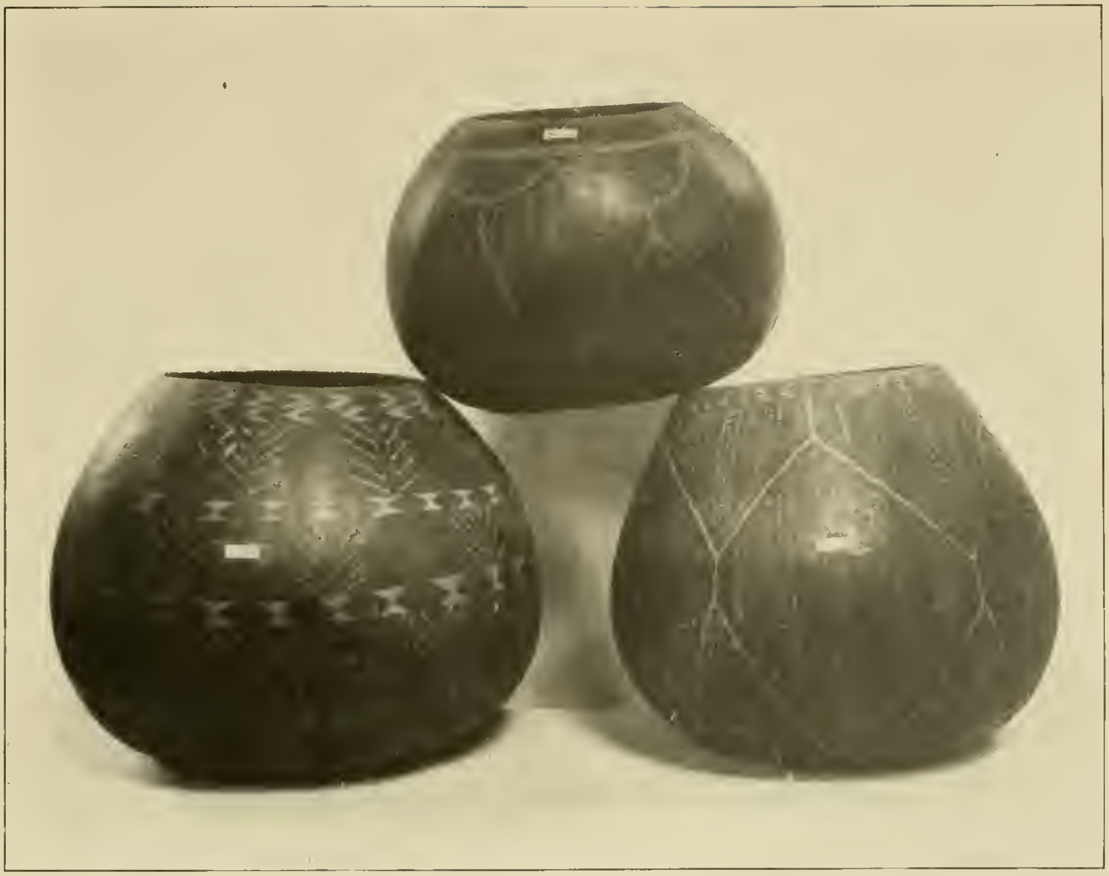


F

PLATE XXXVI.

NA IPU PAWEHE.

The upper figure represents the umeke pawehe; the lower one the huewai or water-bottles. The decoration on the bottle gourds shows little differentiation between the two colors, making a photographic copy of the design difficult to obtain.



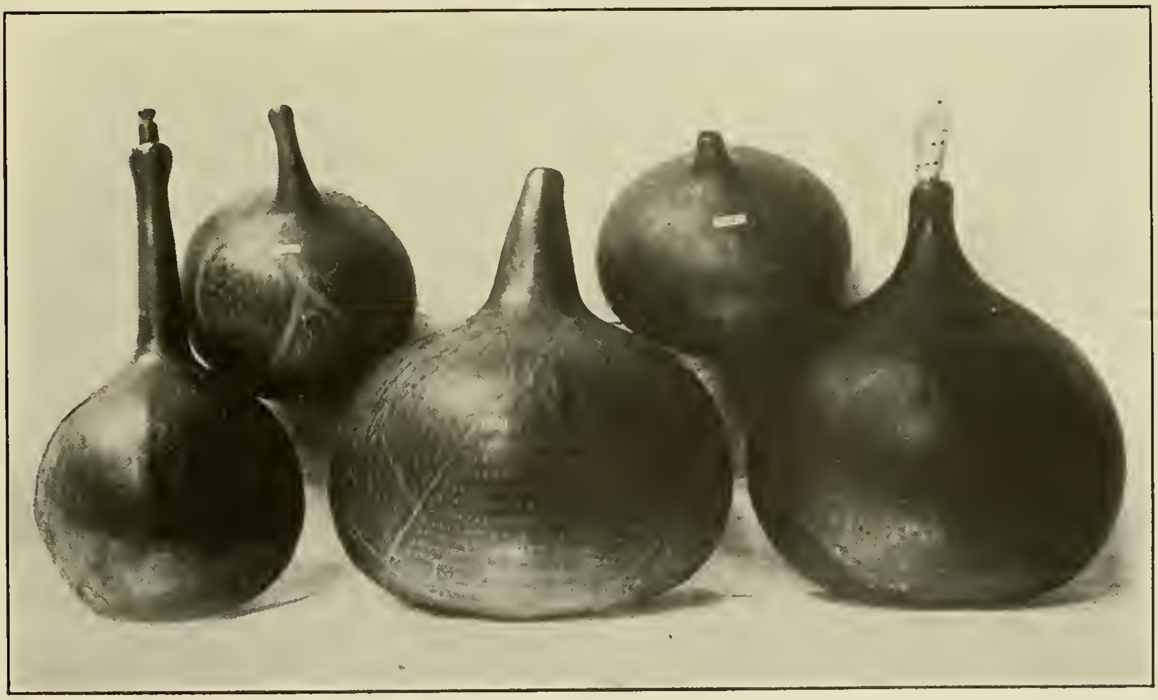
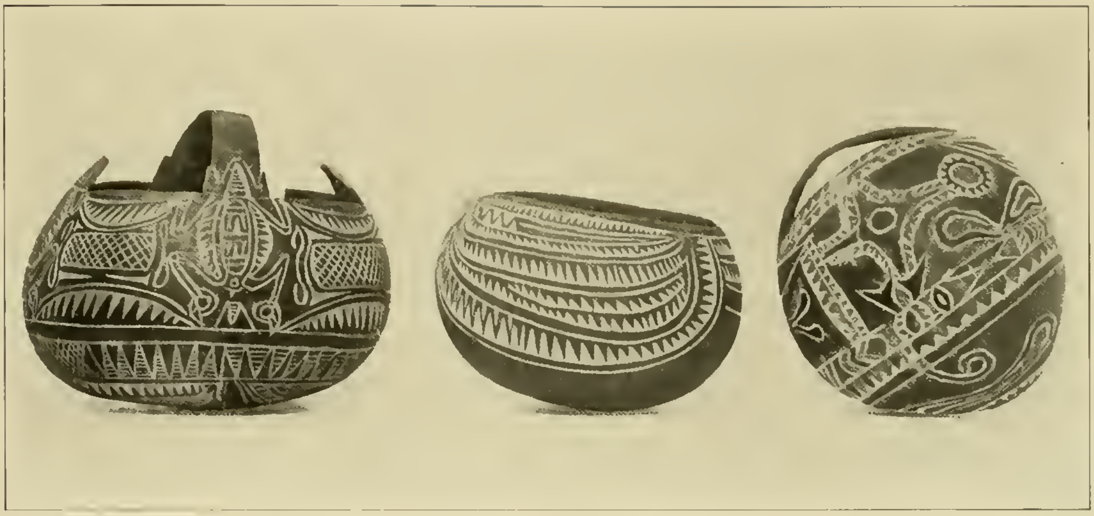


PLATE XXXVII.

CARVED COCONUTS.

The upper group represents New Guinea carvings; the lower, beginning on the left hand, a Marquesan carved cup, a Fijian oil bottle and a Fijian cup.



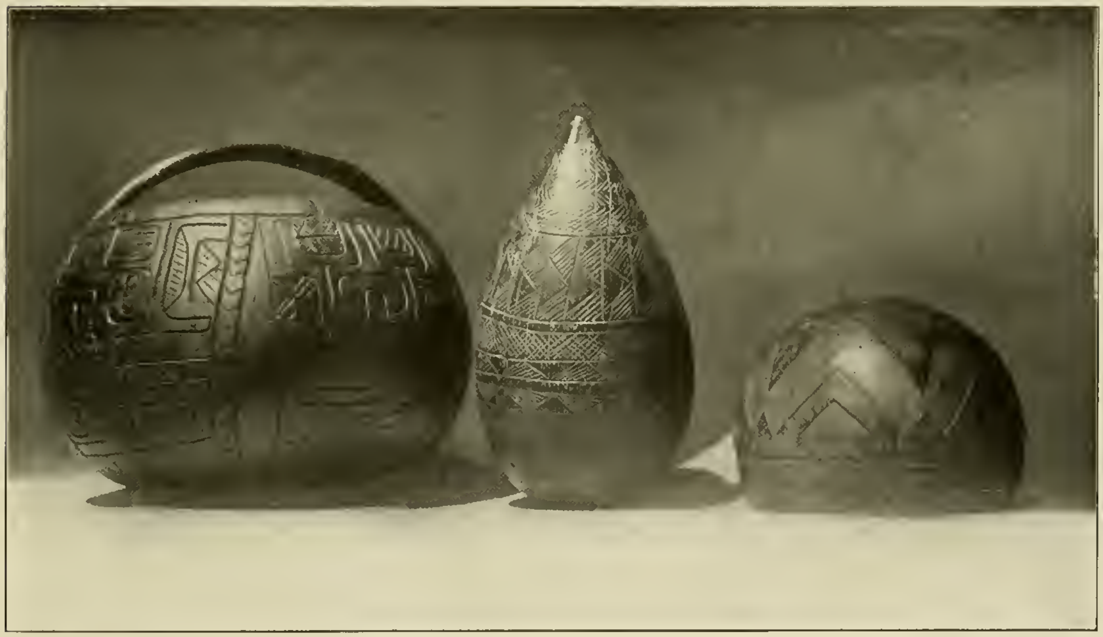


PLATE XXXVIII.

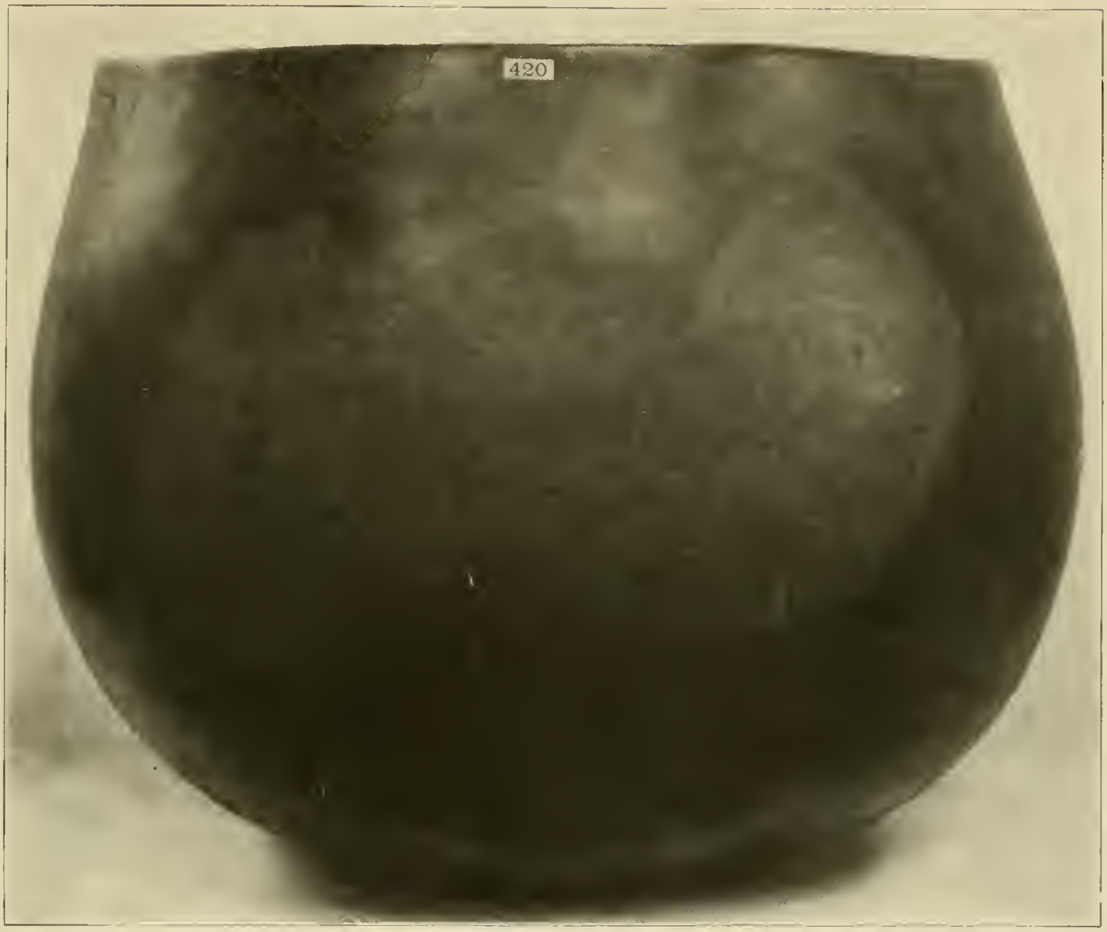
UMEKE LAAU.

This fine umeke (No. 9530) is shown in plan and profile; it is 20.7 inches in diameter and 8 inches deep; the rim is undercut, and the polish is the native.

PLATE XXXIX.

UMEKES.

The upper figure represents Umeke No. 420, of kou, 61 inches in diameter and 14 inches deep. The lower group shows various forms of umeke.


420

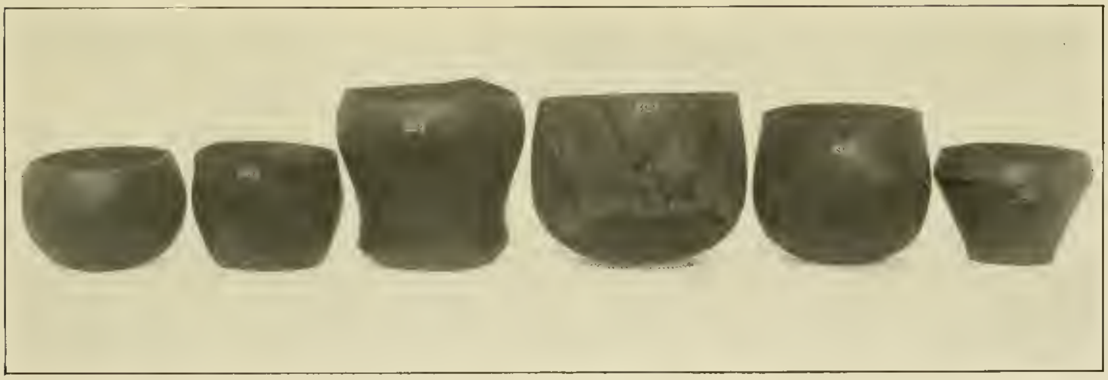
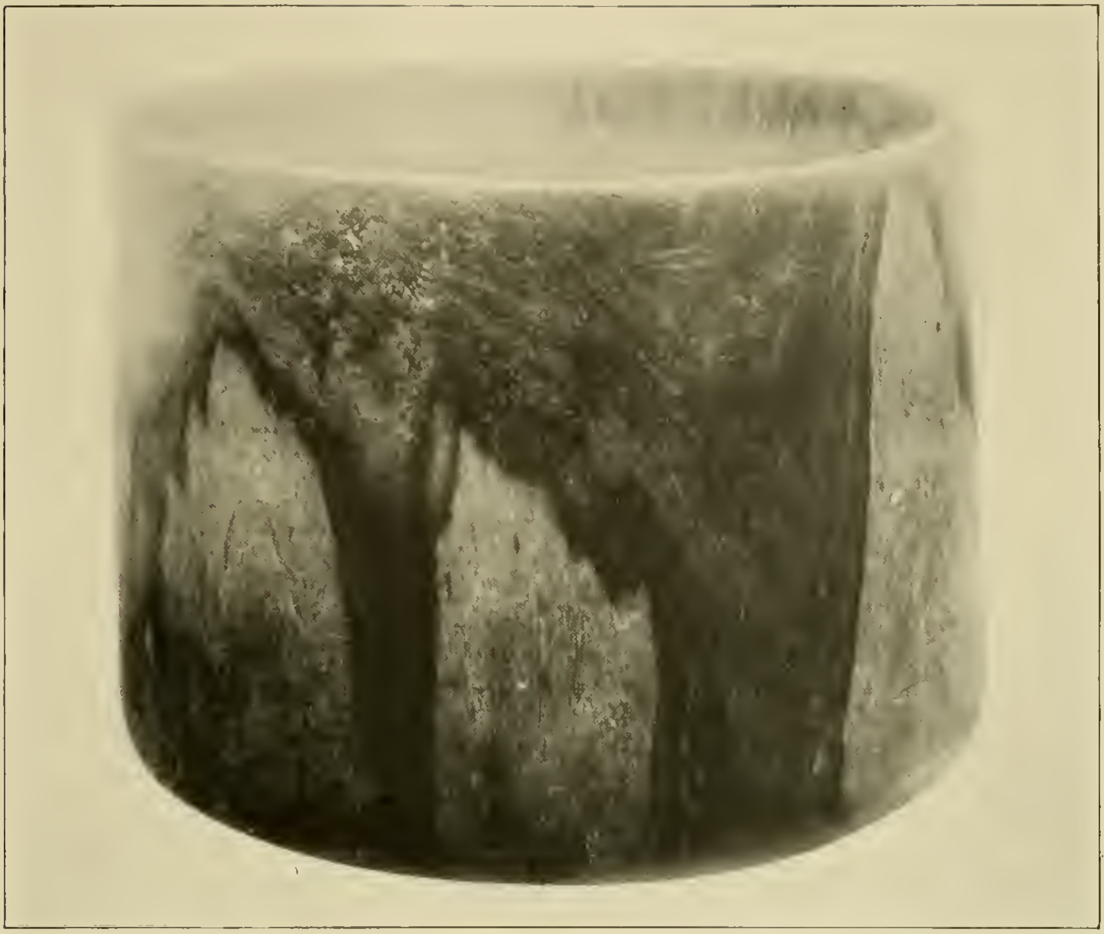


PLATE XL.

UMEKES.

The upper figure is of an umeke in private hands; loaned by a former owner for examination and illustration. The lower figure is No. 418 in the Museum. It is from the Queen Emma collection, and is 69.5 inches in diameter and 6.2 inches deep.



PLATES

PLATE XLI.

Two views taken from nearly the same position on a small stream near Hilo, during the eruption of 1880-81. In the first the lava flow has just reached the brink of what was a small waterfall: this has been boiled up and the molten rock is taking its place for a fall of some twenty-five feet. By daylight the falling lava looked dull red or black, but at night resembled more a flow of blood. During the night the pool was dissipated in steam, and the second view shows the pool utterly obliterated by the lava. This is by no means an uncommon occurrence in the Hilo region where the water courses are often in the path of the descending lava stream.

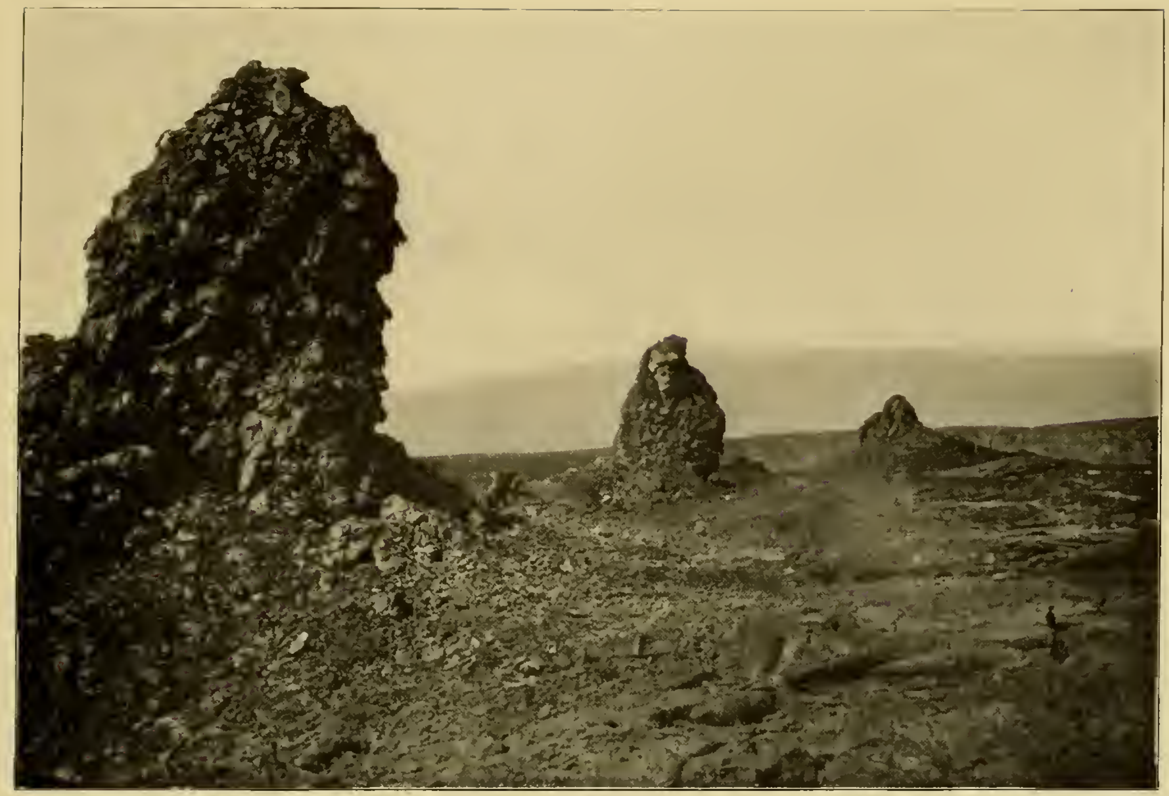
PLATE XLII.

A descent into Halemaumau when the lava in the foreground was too hot to step upon. Very little vapor was present and no sulphurous fumes.

PLATE XLIII.

The upper figure shows "The Three Sentinels," spent blow-holes on the north edge of Halemaumau. Although taken several years ago, the photograph well represents the present condition of these cones.

The lower view was made by the author a few years ago of the surface overflow from Halemaumau falling into the break at the east side of "Little Beggar."



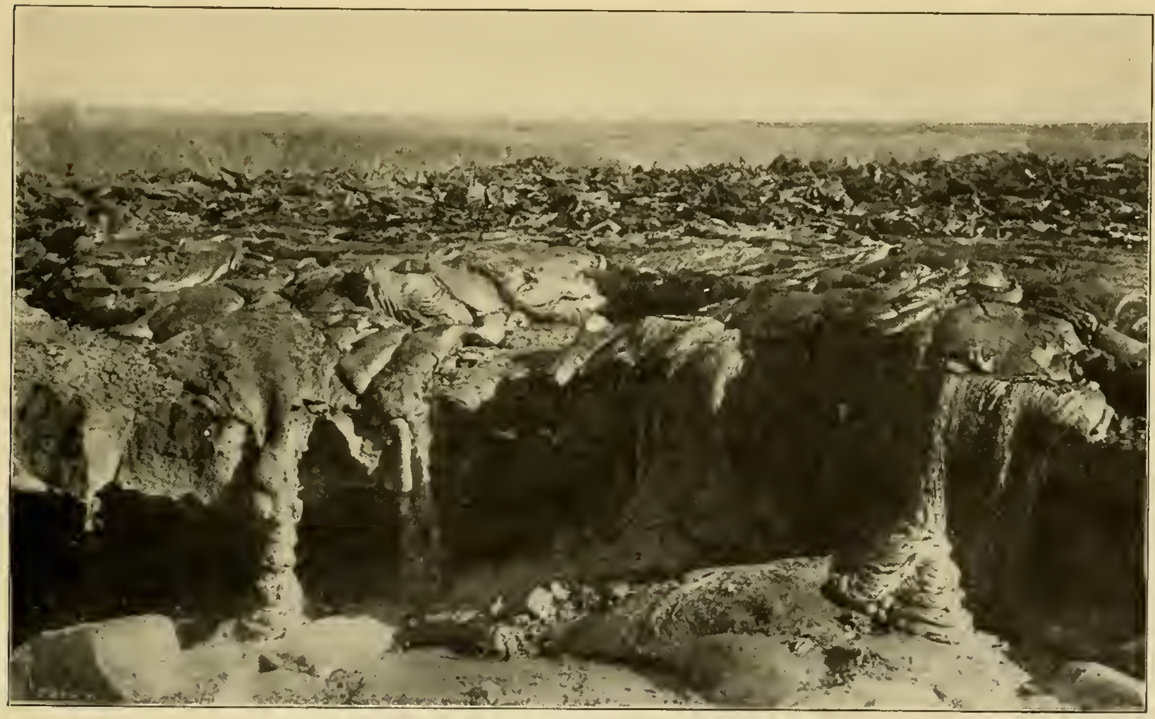


PLATE XLIV.

Two views of pools in Halemaumau. The upper shows the self-made embankment formed of crusts and over-flows. Note the absence of steam or other vapor over the active pool. The lower shows the dam separating the pools. The surface of the lava seems smooth as water.

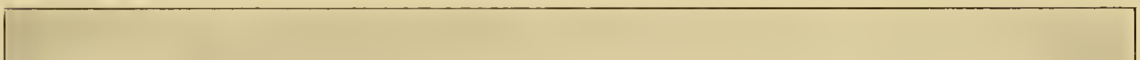


PLATE XLV.

A cone in Halemaumau: note the outer wall of precisely the same material.

The lava pool below the rim of Halemaumau. The surface near the shore is hard and accessible. Little vapor rises from the central portion which is active.

PLATE XLVI.

A portion of drawn out cooling lava from lava-fall.

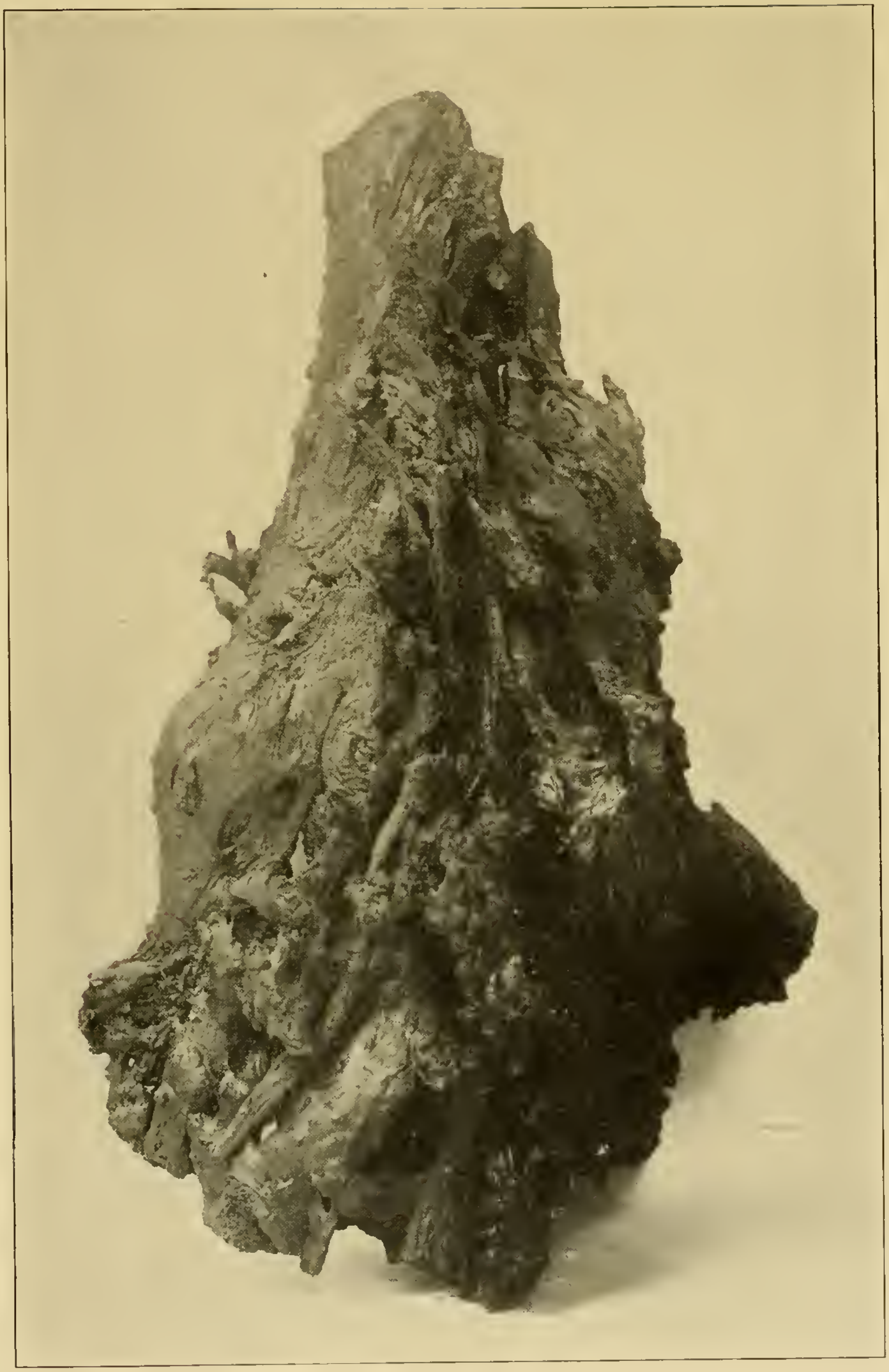


PLATE XLVII.

A small mass of a-a, natural size.

5412

PLATE XLVIII.

A cave stalagmite of the slender variety. Broken from the floor of a cave in Kilauea.

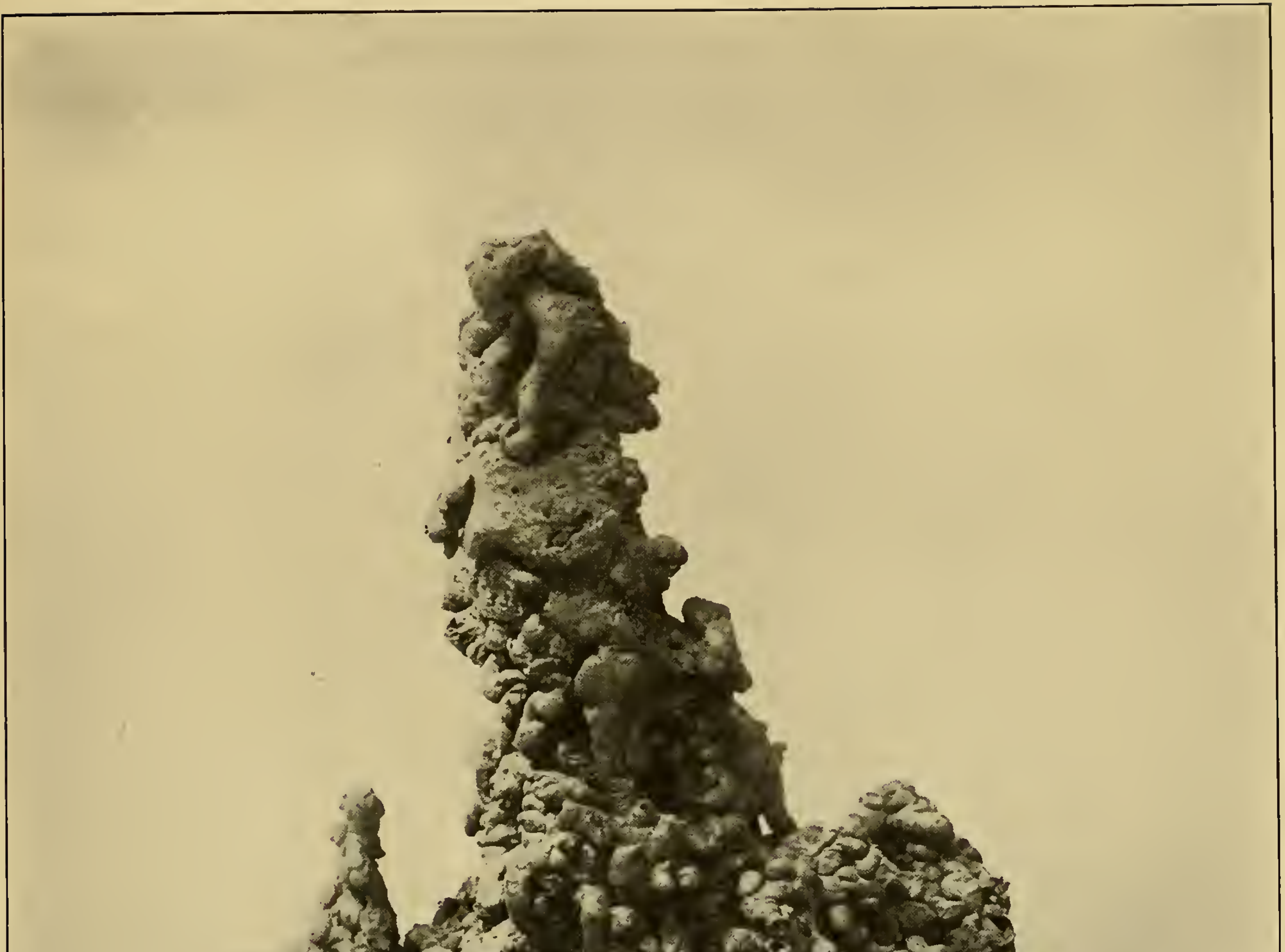


PLATE XLIX.

The broader form of cave stalagmite from Kilauea. The drops near the bottom seem to be hollow, and have been broken in extracting the specimen from the cave floor. This form is less common than the last.

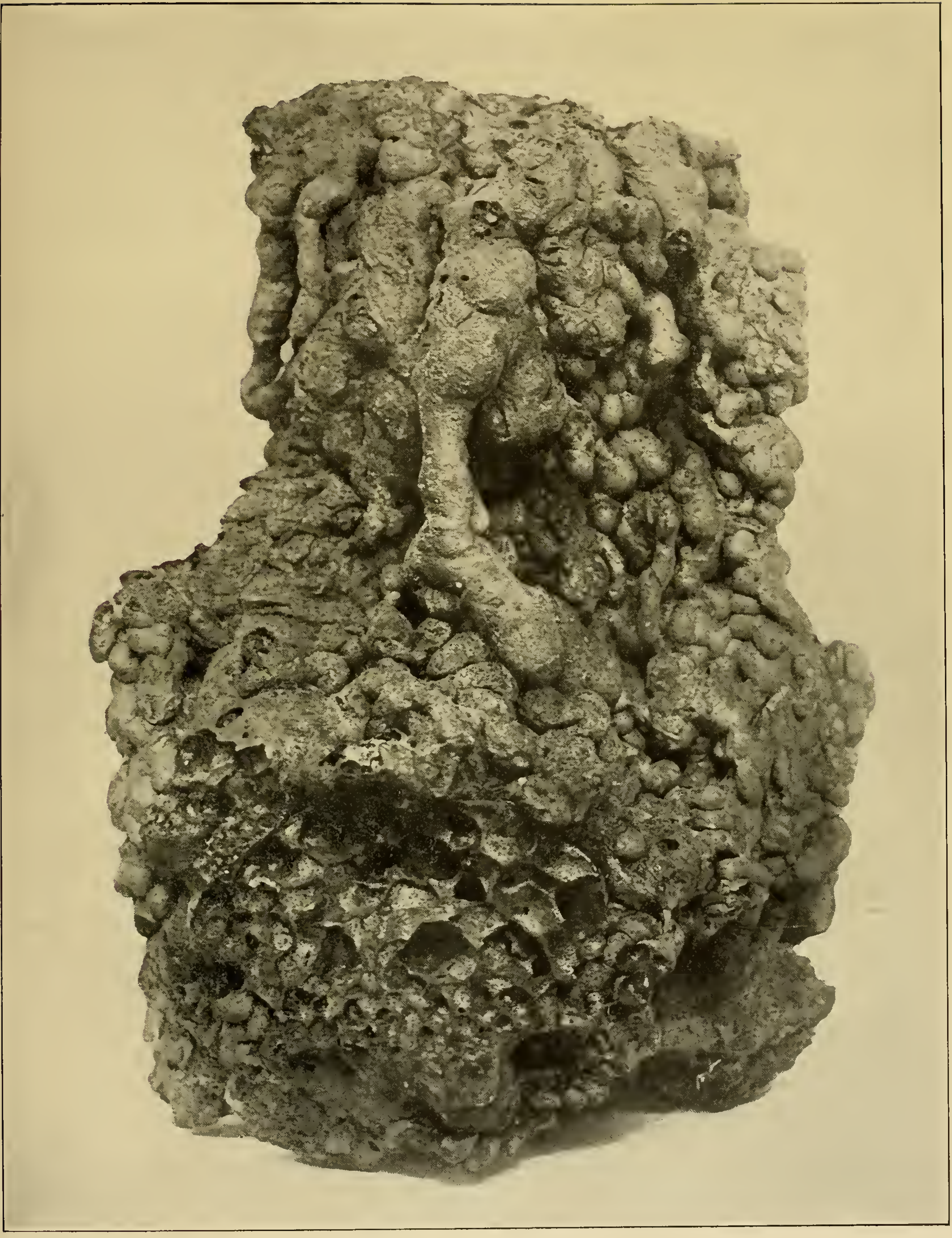


PLATE L.

POOL IN HALEMAUMAU.

The raised lake in March, 1894. Note the extent of escaping steam from the upper edge of the Halemaumau pit, which is more widely diffused owing to previous rain. There is little escape of steam from the lake surface, and that is concentrated in two places. While the overflow of the lava is irregular, the general level of the rim is preserved. The stone blocks in the foreground mark the trail.

PLATE LI.

VIEW OF POOL IN HALEMAUMAU FROM BELOW.

View taken on March 20, 1894. It shows well the overflows which make the present floor of Kilauea.

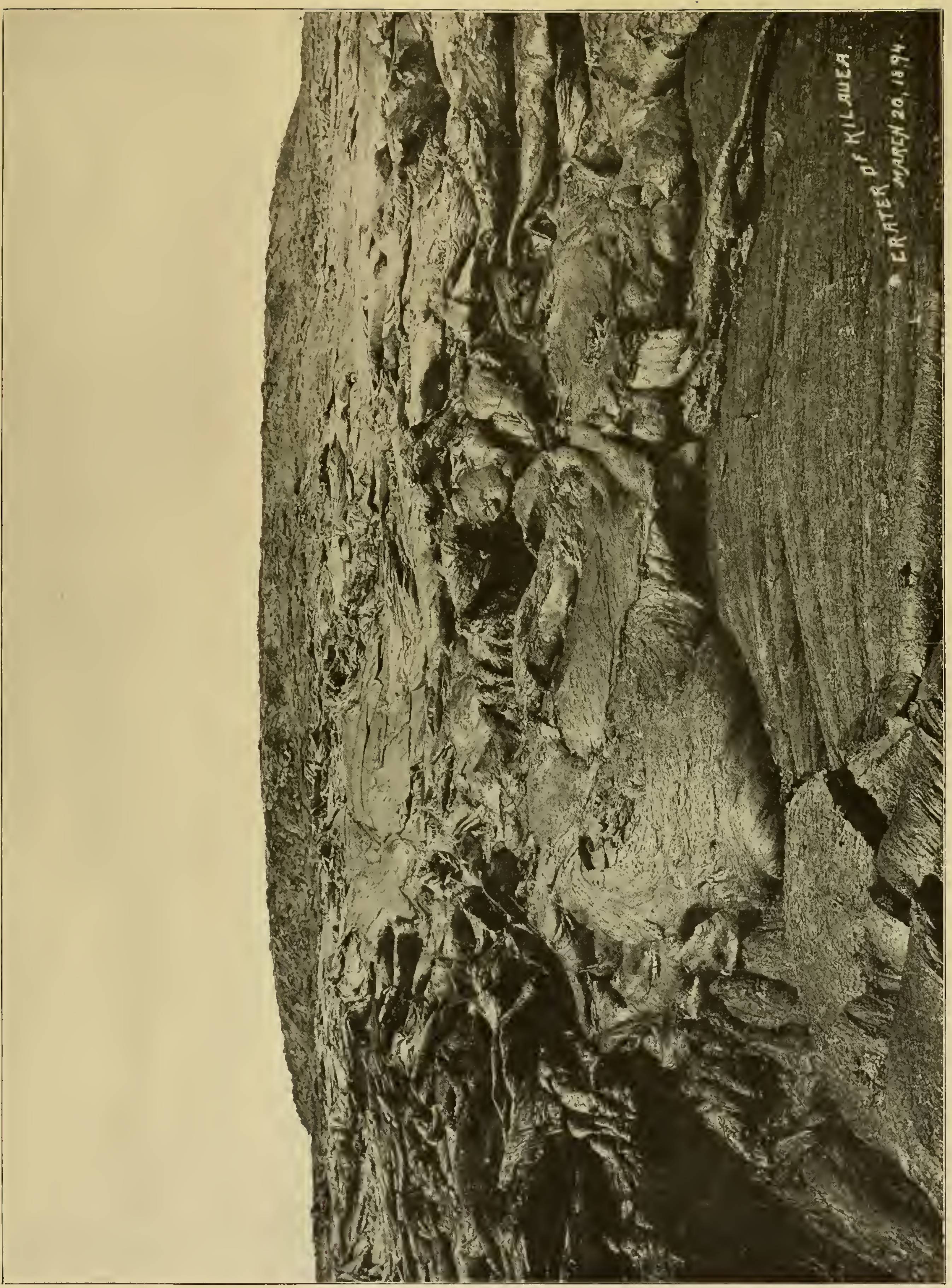

CRATER OF KILAUEA.
MARCH 20, 1894.

PLATE LII.

Pool in Halemaumau.

Showing the pool of the previous plate, but from a slight elevation. The level surface of the pool indicates the curvature of the crater floor in the neighborhood.

PLATE LIII.

The South Lake and Island.

The elevated region around Halemaumau at this time was very irregular, and the lava crust around the rim of the pools was much cracked. The cone on the right was difficult of access. The stranded island is distinctly shown.

PLATE LIV.

CONE IN HALEMAUMAU.

A small pool of lava is seen at the base of the cone. The abundant sulphurous vapors made the ascent of this cone very unpleasant and even dangerous. The rim of Halemaumau is seen in the middle distance.

PLATE LV.

CONE IN HALEMAUMAU.

Note the loose rectangular blocks and apparent layers in the mass of the cone.

PLATE LV.

PLATE LVI.

CONE IN HALEMAUMAU.

At this time five hundred feet high and perhaps two thousand feet in diameter.

PLATE LVII.

The Empty Pit.

The edge of Halemaumau after the descent of the cone. The walls are not perforated by galleries, nor is there any visible exit at the bottom. At times the conical pit was free from smoky vapors for hours, although hot air was continually rising.

PLATE LVIII.

On the brink of the pit. Note the walls built up by successive overflows.

VOLCANO

PLATE LIX.

The peculiarly cracked condition of the lava in the foreground is probably due to the rise and fall of these banks, of which portions are ready to break off and form islands.

Plate LIX.

PLATE LX.

Dana Lake.

This small lake, which was a side issue of the main pool, and of little depth, showed all the phenomena of the main pool, and the lava fountain in the foreground is very characteristic of these outbreaks. The deep red color of the jets appears black in the photograph. Taken by J. J. Williams.

PLATE LXI.

SOUTH LAKE.

Note the great extent of smooth surface. Accessible as shown in the foreground.

PLATE LXII.

The so-called floating islands—portions of the cooled crust or of the broken banks. These islands lasted for some time, and when the pool was drained grounded on the bottom.

PLATE LXIII.

A Flow of Aa.

The flow moves slowly onward, tumbling the rough masses of all sizes of which it is composed, and seldom shows any signs of liquid lava except possibly here and there at the lower edges.

PLATE LXIV.

The source of the flow of 1880–1881 after the violence had ceased. The molten lava is issuing quietly from cracks on the summit of the flow. This well illustrates the outflow from cracks below the initial spatter cone or cones. The cones are shown in the sketch by Furneaux given in the text.

PLATE LXIV.

PLATE LXV.

A crack in the floor of Kilauea. This would illustrate the so-called canals spoken of by Rev. T. Coan and others. These cracks, if opening slowly, make little noise; but a sudden crack is accompanied by a sound like the discharge of a great gun.

PLATE LXVI.

D. Howard Hitchcock's painting of Kilauea in 1896, with the raised rim of Halemaumau to the right of the centre. This is in the picture gallery of the Museum.

Plate LXVI.

PLATE LXVII.

The crater of Mokuaweoweo, on the summit of Mauna Loa, during the eruption of 1896. From a painting by D. Howard Hitchcock, now in the picture gallery of this Museum. The snow cap has melted on the lee side of the crater. Mauna Kea, snow-capped, appears on the right.

3 2044 072 224